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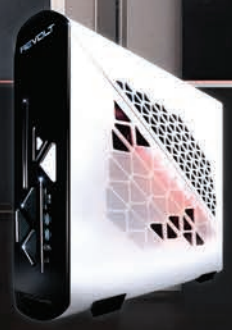

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Gordon Mah Ung

PUBLIC SERVICE AD

I CAN STILL REMEMBER the release to manufacturing (RTM) of Windows XP on Aug. 24, 2001. Sure, I was already running Windows 2000 on some boxes, but many of them, especially the gaming-focused PCs, were still on Windows 98 SE or—shudder—Windows Millennium. For enthusiasts, Windows XP was a major step forward, as we finally got multi-processor support without the wonkiness of Windows 2000 in games.

FutureMark hardware polls showed that enthusiasts and gamers made the jump from Win9x to Windows XP at far faster rates than previous OS migrations. At the time, Windows XP was proclaimed to be the most "secure" Windows OS ever! That turned out not to be true, but for its day, Windows XP was a very solid OS that gave me years of service.

I say all this because if you're still rolling Windows XP, just stop. I know *Maximum PC* readers upgrade at far faster rates than civilians, and the vast majority of you aren't using XP, but I know there will be some hold-outs.

With Microsoft support for it over forever, it's a hole-filled barge floating in 50-foot Atlantic Ocean waves. I once took an unpatched Windows XP machine and drove outside the firewall to see how long it would last. Within two minutes, I had lost control of the machine to malware and was forced to power down—and that was six years ago.

That doesn't mean Windows XP will just keel over and stop working, but you have to be extremely careful how you use it. Hey, there are people who still have 25-year-old PCs running programs in DOS hooked up to ancient dot-matrix printers. You can do the same with a Windows XP box, but you'll have to isolate it. Maybe even in the same Faraday cage that Gene Hackman used in *Enemy of the State*, because Windows XP is a wide-open OS at this point. Sure, you can keep your anti-virus programs updated and maybe even buy third-party tools that claim to keep XP secure, but without access to the source code or to issue OS patches, this old war horse is done.

It's really not worth the time and heartache when there are such great choices today, such as Windows 7 or, if you install Classic Shell, even Windows 8. There's better driver support, a real 64-bit version, and a long, long list of tangible benefits of moving on to a new OS. So, really, take my word for it, you Windows XP holdout—make the move and let Windows XP go out with a modicum of self-respect.

Gordon Mah Ung is Maximum PC's deputy editor, senior hardware expert, and all-around muckraker.

↘ submit your questions to: comments@maximumpc.com

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THE NEWS

Desktop Gets Love

Brace yourself—the rest of this year should see some significant upgrades from Intel

AFTER A PARTICULARLY boring 18 months of processor upgrades from Intel, the chip giant finally has some good news for its loyal enthusiasts: The company says it will release no fewer than four new CPUs aimed squarely at our still-rolling desktop machines.

First on tap is its Haswell-E processor, which will be the first consumer Intel chip with eight physical cores (plus Hyper-Threading), instead of topping out at six. It will also finally usher in the era of DDR4 main memory. And as its name implies, Haswell-E will be based on the 22nm Haswell microarchitecture, but it will use an updated version of LGA 2011 incompatible with current motherboards, and a new chipset called X99. The chips won't be out until later this year. But those looking for a hardware fix will get something from the new CPU code-named "Devil's Canyon."

For the most part, Devil's Canyon will be a binned-up CPU based on the existing LGA 1150 Haswell microarchitecture. However, it will be aimed squarely at the enthusiast and will include a new, improved thermal interface material (TIM). If you think of a CPU as an Oreo cookie, TIM is the white heat-transferring stuff that's sandwiched between the actual CPU cores below and the CPU heat spreader on top. With Haswell and Ivy Bridge, some accused Intel of cheaping out by using a lower-cost thermal material. That doesn't appear to be the case with Devil's Canyon, but Intel hadn't mention specific ingredients as this issue went to press.

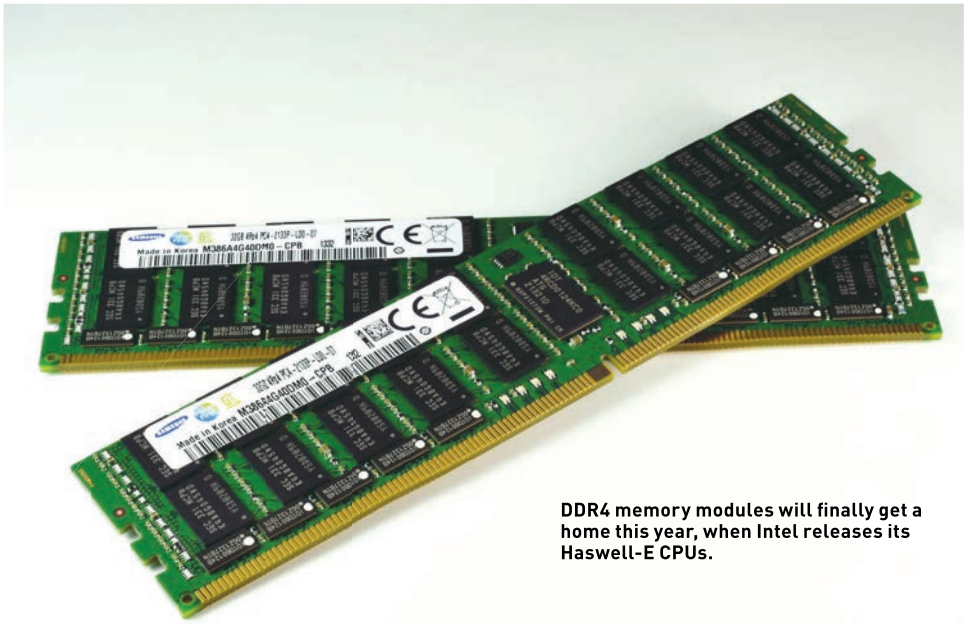
Budget builders will also get lots of love this summer, when Intel releases its "Pentium Anniversary" edition CPU. In short, the chip will be unlocked, cheap, and likely go against AMD's low-cost unlocked competition.

The final icing on the enthusiast cake will be a socketed version of the CPU code-named Broadwell. Broadwell will be the first chip to use Intel's new state-of-the-art 14nm process. There was much hand-wringing last year, when leaked roadmaps showed that Broadwell would not be available in a socketed chip. Many believed this signaled the "death of the PC," as it would end the ability to upgrade the CPU or to make the granular choices that we do. Intel denied reports that it intended to end socketed CPUs. It said that because Broadwell was focused on low power, it was suited for laptops and NUC-style machines. Intel has now had a change of heart, and said we will see a Broadwell CPU in a socket by the end of this year.

Did Intel suddenly strike a rich vein of CPUs while mining for silicon? No. Intel's motivation is the strongest one available: money. Intel veep Lisa Graff said the company has seen huge interest among enthusiasts for Intel CPUs. She said desktop processors have increased shipments by 7 percent, and the company set a record for Core i5 and Core i7 sales last year. And when the company sat down to see what was fueling the increase in sales, it was the thing that dinosaur financial analysts and the mainstream tech press have said was dead: the desktop.

The company says that when broken out, the desktop still made up 43 percent of sales, with notebooks taking the rest.

—Gordon Mah Ung



DDR4 memory modules will finally get a home this year, when Intel releases its Haswell-E CPUs.

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Facebook Offers $2B for Oculus VR

In a surprise move shortly after the Games Developer's Conference in March, Facebook announced it was buying Oculus VR, makers of the Oculus Rift virtual reality headset, for $2 billion—$400M in cash and $1.6B in stock. Not the kinds of ones and zeroes that we expected in the Rift's future. Facebook CEO Mark Zuckerberg was apparently quite taken with the newest development kit, which has solved a few motion-sickness problems and added the ability to "lean" in virtual space. In a public statement, he said, "Mobile is the platform of today, and now we're also getting ready for the platforms of tomorrow." Under the terms of the agreement, the acquisition will remain an independent unit within Facebook. **–SK**

Windows 8 Trade Secrets Exposed?

A former Microsoft employee working out of offices in Lebanon and Russia was arrested and held without bail after being accused of leaking Windows 8 trade secrets to a French blogger. Microsoft alleged the former employee, Alex Kibkalo, shared actual source code, which it considers "proprietary and confidential trade secrets." According to court documents, Kibkalo shared the code for a software developer's kit, which could be reverse-engineered to bypass copy protection. After working with the FBI, the company believes that Kibkalo sent the files from a Microsoft server and communicated with the blogger using MSN Messenger. Investigators believe he was motivated by a poor performance review he received after having been employed at Microsoft for seven years. **–PL**

Nvidia Unveils Dual-Titan Card

At the annual GPU Technology Conference in San Jose, Nvidia announced the GeForce GTX Titan Z, a dual-slot video card that combines two Titan Black GPUs and 12GB of VRAM. Titans are based on Nvidia's Tesla line of professional rendering cards, which have a lot more shader processors and texture mapping units than traditional gamer cards—and appropriately higher price tags. Nvidia is asking $3,000 for the Z, putting it in a gray area between gaming and professional use. The company hasn't yet announced details on the release date or power consumption. AMD is also releasing a dual-GPU card called the Radeon HD 295 X2. Check out the details on page 93. **–TM**

Tom Halfhill **Fast Forward**

FUTURE SHOCK VS. FUTURE FIZZLE

I'M OFTEN ASKED about a new trend or technology that looks potentially disruptive. The Internet is buzzing with discoveries, inventions, and breakthroughs. Usually, though, they're too distant from practical applications to worry about.

Example: quantum computing. The concept is to encode and process data using quantum-level simultaneous states instead of conventional binary states. In theory, this radically different approach could dramatically increase performance. A Canadian company has created a stir by introducing the D-Wave One, claimed to be the world's first commercially available quantum computer. But critics say it's no faster than an ordinary digital computer. Others snort that it's not really a quantum computer at all. Bottom line: this technology isn't coming to our PCs anytime soon.

Truly new technologies are like newly famous movie stars—before becoming overnight successes, they usually spend years waiting on tables. Consider extreme ultraviolet lithography (EUV or EUVL), which uses short-wavelength light to etch smaller circuits on silicon chips. (Actually, these wavelengths are below the visible threshold, verging on x-rays.) I wrote about EUVL in *Maximum PC* in 2003, when Intel expected to begin mass production in 2009. Now it's 2014, and EUVL still isn't here.

Although EUVL works, it's too slow for mass production and is bleeding expensive. It looks doubtful even for 10nm fabrication, which is two generations beyond today's 22nm technology. Maybe we'll see it at 7nm, the step below 10nm. Or maybe not.

Meanwhile, some really disruptive trends have sprouted from existing technologies. Apple's iPhone and iPad weren't technological breakthroughs, but they combined sleek industrial design with clever marketing. Facebook succeeded where Friendster and MySpace stumbled. Smartphones are obsoleting compact cameras because they make photo sharing easier and are integrated in portable devices that people already have.

So, when someone trumpets the latest breakthrough, be patient. Time passes quickly, but future shock often comes slowly.

Tom Halfhill was formerly a senior editor for *Byte* magazine and is now an analyst for *Microprocessor Report*.

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Thomas McDonald
Game Theory

RETREATING FROM THE UNCANNY VALLEY

FOR THE PAST few years, we've been seeing a refinement of low-res and retro-style game visuals. The first time that they really impressed me with their visual beauty was in Incredible Fishing. The use of color and shape created a kind of neo-cubist effect that gave the game a unique aesthetic.

Before that, the trend was already emerging with titles like Cave Story and the work of NimbleBit. More and more, I see titles hitting Project Greenlight and releasing to mobile devices with graphics that eschew the cutting edge in favor of the stylishly simple, to wonderful effect.

The Last Door derives much of its suspense from terrific sound design and writing, but the use of limited graphics and old-school adventure game tropes contributes mightily to the overall effect. Playing the game, I kept thinking this would be *less* scary if it looked more realistic.

Obviously, adopting low-res can be a choice driven by budgetary reasons or nostalgia, rather than aesthetic concerns. But I can't help wondering if we're seeing a reaction to the bleeding edge of high-end graphics in games. As we get closer to the Uncanny Valley, are we drawing back?

The "valley" is that moment when a synthetic representation of a human being becomes so realistic that it is unappealing. Once a model becomes truly photorealistic, the mind stops seeing it as some kind of avatar and begins to perceive it as something almost-but-not-quite human, and that "not-quite" bothers us. It's no longer a really good model, but a really bad human.

Games will eventually fall into the valley, but the retreat to low-res visuals by some designers show us that one way forward may lead through the past. We're confident enough in what we can accomplish with powerful 3D engines that we no longer have anything to prove, and thus we can play with forms and styles we abandoned, and give them new life.

Thomas L. McDonald is Editor-at-Large of *Games Magazine*.

6GB GTX 780s Coming

Hardware maker EVGA announced that it is rolling out a variety of Nvidia GeForce GTX 780 cards that will have 6GB of VRAM instead of 3GB, perhaps detecting the rising interest in ultra HD monitors that would take advantage of that much memory (at 3840x2160, you have the equivalent of four 1080p monitors). Interestingly, pricing starts at $550, only $50 higher than the street price of the least-expensive 3GB version. Of the two cards announced, one will use the company's proprietary, dual-fan "ACX" cooling system, while the other will use Nvidia's reference design (which is still pretty nice). **–PL**

Microsoft Criticized Over XP Support

Anti-virus company Avast published an open letter to Microsoft on its website, telling the maker of Windows XP that it is a "big mistake" to stop issuing security updates for the old operating system, which MS planned to do on April 8th. Avast estimates that nearly 50 million of its customers are still using XP (which it plans to support for three more years), indicating to it that Microsoft had not successfully transitioned its user base to an actively supported OS. Although anti-virus programs can fight malicious software, they're not optimized to protect against malicious people breaking into a network and exploiting unpatched security holes. Avast also estimates that nine out of ten ATMs still run XP. **–PL**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

REAR-VIEW CAMERAS
The Department of Transportation proudly announces that you'll never back into another car again.

DOGECOIN
Friendly and whimsical community donates to important causes, like water and space travel.

UK CD RIPPING
The UK legalizes extracting audio from store-bought CDs, now that no one uses those anymore.

TRAGEDIES

TIME WARNER CABLE
May merge with Comcast to rule the galaxy with an iron fist, pending regulatory approval.

TRANSPARENT TEXTING
Apple patent encourages us to continue driving and walking while staring at a phone.

DEATH THREATS
Oculus VR CEO collides with the power of anonymous Internet anger after Facebook acquisition.

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Quinn Norton
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THE INTERNET OF (NOT YOUR) THINGS

IT ALL STARTED with the magical refrigerator that tells you when you're out of milk. Or better yet, Amazon sends you a gallon of delicious Tuscan milk as soon as you get low. Then we thought of toasters and vacuum cleaners being on the Internet. Maybe pens or irons or cars or even phones could be online, too (though based on my local reception, that last one isn't happening).

This was the idea of The Internet of Things, a time in the glorious future when all of the items in our lives chatter with each other and online services to make our hellishly difficult modern lives a breeze to walk though, all managed and tracked by machines of loving grace.

But as amusing as the retro-future hyperbole is, something like the Internet of things is taking over what we buy and use. It's not software being built to make everything easier, like automagically sending you another three wolf moon shirt when your last one wears out, but to control how you can use the physical things that have software in them—which is everything, nowadays. As click-through software creeps into the world, buying a thing doesn't really mean you own all of it.

Recently, coffee maker Keurig announced they were joining the illustrious world of printer cartridges, remote controls, and auto makers, using DRM to lock in their customers to "licensed" providers. Even worse, a terms-of-service on a physical object that is part software can render it useless without a subscription fee, illegal to sell used, or even get you sued or prosecuted for modifying a thing.

This is because, as a society, we've handled intellectual property so poorly, and we continue to as the intellectual merges with all the property. If you want to get what you paid for, you're going to have to start looking closer at the contract that says you don't get it.

Quinn Norton writes about copyright for Wired News and other publications.

Rent Your Next Game Engine

At the Games Developer Conference in San Francisco, Epic Games announced that Unreal Engine 4 would be available to developers for $19 a month, plus 5 percent of the product's gross income. In years past, companies negotiated an up-front cost, which could easily spiral into hundreds of thousands of dollars. Epic's previous offer for UE4 was $99 a month, then 25 percent of all proceeds after the first $50,000. The $19 package includes UE4 source code hosted on GitHub, the Unreal Editor, and sample templates. The editor also has a built-in "Marketplace" to provide both free and paid content. One-time licensing fees are still available for those who have deep enough pockets.

Not to be outdone, competitor Crytek upped the ante. The following day, it unveiled its own subscription plan for CryEngine, also in its fourth generation, at half the price—and with no royalty percentages. The company declared that customers would have access to the same toolset used to make Ryse: Son of Rome. But the method of accessing source code, and the possibility of exchanging assets in a UE4-like marketplace, had not been announced at press time.

In a separate announcement, Crytek also said that it was incorporating AMD's Mantle API into CryEngine. This API is designed to replace DirectX for better hardware optimization, although it supports a small number of AMD cards for now. Also at GDC, Microsoft detailed its plans for DirectX 12, which appeared to take inspiration from Mantle's core concepts of low latency and more efficient use the CPU. **–TM**

Microsoft Snooped on Hotmail

During the investigation of a former employee who Microsoft believed to be leaking source code (covered on page 14), it turns out that the company was reading the person's Hotmail account, a service owned by Microsoft. The company characterized the action as a search of its own property, in the interest of halting a leak of its own proprietary information. Initially, the company said it would amend its privacy policy to allow for access to accounts under specific circumstances. But according to Reuters, Microsoft backed off that plan after some public backlash and will instead "refer all suspicions of illegal activity on its email services to law enforcement." **–PL**

Modular PC Project Hits Snag

Back in January, hardware maker Razer announced Project Christine, a plan to create a modular desktop PC. However, after component manufacturers did not express much support or interest, the project appears to be on hold. In an interview with gaming website Polygon, Razer's CEO Min-Liang Tan said, "All they ask about is, 'How much money can I make out of this?' They're not interested in innovation at all." When asked why Razer didn't take on the task on its own, Tan indicated that modular component support needed to be available in stores to maintain timeliness, rather than Razer creating a second market of modular device containers to come after. **–SK**

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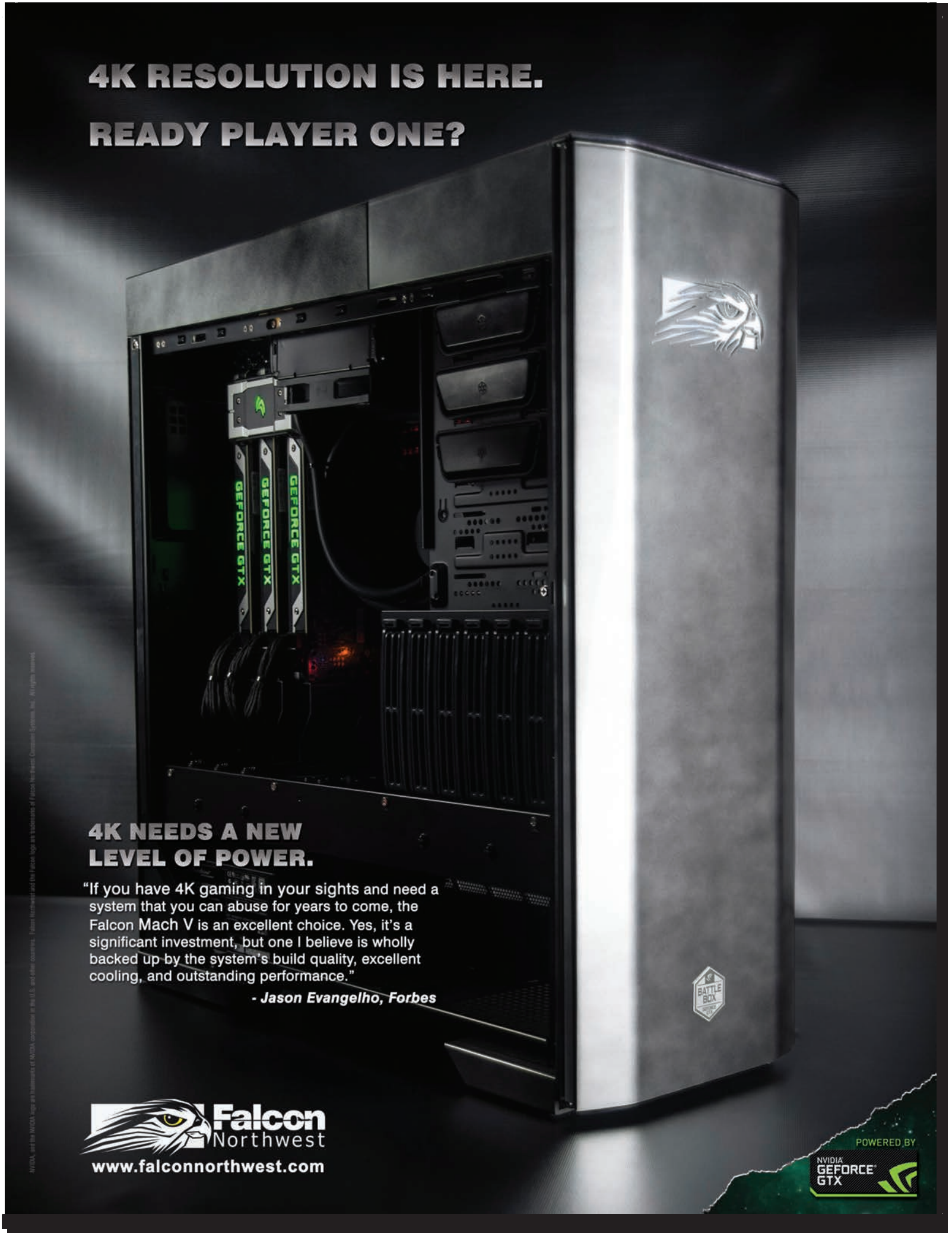
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THE LIST

VIRTUAL REALITY GADGETS AT GDC 2014

8 PROJECT MORPHEUS

The biggest surprise of the show was Sony's foray into VR. The headset is eerily similar to the Oculus Rift.

7 OCULUS RIFT DEVELOPMENT KIT 2

It features a higher-res 1080p screen and supports positional head tracking.

6 VIRTUIX OMNI TREADMILL

No true VR experience is complete without the ability to walk around virtual environments.

5 PRIOVR

For those who don't have space for the Omni, there's the PrioVR suit, which tracks your body movements.

4 PHASESPACE

Technically, this is for motion-capturing, but who knows? Perhaps one day we could be using these suits for VR!

3 SEEBRIGHT

Using fancy lenses and mirrors, the Seebright headset attempts to turn your smart phone into a VR device.

2 CONDITION ONE

VR isn't only about games. Condition One stitches together multiple cameras to create three-dimensional surround video.

1 UNREAL ENGINE 4

Next-generation VR hardware needs a next-generation game engine. Enter UE4.

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Work easy, play hard Windows 8

HEAD TO

BY TOM MCNAMARA

Mini-ITX vs. MicroATX Systems

Few things evolve more quickly than the desktop PC, but there is one constant: the process of getting smaller. The first computers took up entire rooms (and required a college degree to operate). But these days, you can get a gaming PC the size of briefcase delivered to your front door. But if you prefer to build, should you go with a microATX system, or is it time to go even smaller with mini-ITX?

The Corsair 350D microATX tower is on the left, next to the 900D super-tower for scale.

ROUND 1

Performance

Since you're reading *Maximum PC*, you probably already know that it's blistering benchmarks that get our motor running. In fact, sometimes a new rig is more fun to tweak and test than it is to use for "normal" activities. You can actually get some premium mini-ITX motherboards these days that can overclock as well as a full-sized ATX motherboard. They do it by putting extra voltage-regulation modules on a riser card, since the form factor doesn't otherwise leave a lot of room for bonus power phases. But if you want to run more than one video card at the same time, only microATX is big enough to give you that option. It also means a larger case; we've fit a 280mm radiator in the Corsair 350D, for example, with enough room left over for a 120mm radiator elsewhere. That means it's much easier to liquid-cool a whole system for high overclocks.

Winner: MicroATX

ROUND 2

Shopping Options

MicroATX has been around a lot longer than its junior-sized competitor, so the technology is more mature, and there's a wider range of boards. It's the de facto ruler of the modern cubicle farm. As a result, you can fine-tune your budget down to the last dollar and individual spec, whereas mini-ITX has more frequent gaps. However, there isn't much variety in microATX *cases*. Most are designed for a full-ATX motherboard, which happens to take microATX boards as a side effect. If you're looking for something particularly compact, mini-ITX has been getting a lot more love from case manufacturers and enterprising modders. The approaching extinction of the optical drive, coupled with the compactness of SSDs, allows more exotic dimensions and looks. But if you just want a basic tower that's fairly easy to fiddle with, microATX is the way to go. Thus, the winner in this category depends on your needs.

Winner: Tie

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HEAD

The "shoebox" shape is popular with mini-ITX systems because it can fit a full-length video card.

ROUND 3

Costs

If logic ruled the world, a mini-ITX system would cost less because the motherboards and cases are smaller. That means less raw materials. They're not particularly difficult to manufacture, and they don't use exotic ingredients. The problem is in the other typical parts, like the power supply. Mini-ITX systems frequently use a PSU form factor called SFX. These aren't nearly as common as regular ATX units. So, by the laws of supply and demand, SFX units tend to be more expensive for comparable output and build quality. Especially if you want to get fancy with things like modular cables or "gold" ratings. It's also hard to find a mini-ITX case for less than $50, which matters if your budget is tight. In fact, a good one usually hovers around the $100 mark, while you can get a decent ATX micro-tower or mid-tower for half that.

Winner: MicroATX

ROUND 4

Ergonomics

Even when a mini-ITX system can fit a regular power supply, it usually has to be a small one without modular cabling, because there's less clearance in these smaller boxes. Mini-ITX cases like the Cooler Master 130 Elite take a regular-sized PSU, but the unit sticks out the back by an inch or two. Meanwhile, a microATX tower like the Corsair 350D can take pretty much anything. Also consider the accessibility of a tower's drive cages, fan mounts, and motherboard connectors. A "shoebox" ITX case has to have some of its guts removed every time you want to fiddle with a major component. That said, mini-ITX systems are lighter, easier to carry, take up less desk space, and can blend in better with home theater components. It's the ideal LAN party form factor, something you can carry with you on public transit if need be, and even a conversation starter.

Winner: Tie

ROUND 5

Upgrading

Builders like us also like expandability. But as a rule, mini-ITX boards have just two RAM slots. With the four slots common to microATX, you have more options for the future. Two slots compel you to max out your capacity, which means spending around $150 for 16GB, instead of $60-$70 for two 4GB sticks. Mini-ITX also typically has only one card slot, for the GPU. If you want to add more USB 3.0 ports, sound card (they still have their uses!), wireless adapter, or SATA Express coming later this year, then microATX gives you those options, and future options that we're not aware of yet. You're not stuck with the level of technology that's built into the board.

Winner: MicroATX

And the Winner Is...

If you're a performance enthusiast, it's hard to argue for the limited physical space of a mini-ITX system. If you need an HTPC, though, a little mini-ITX box seems like a no-brainer. There are mini-ITX cases large enough to blur the lines, like the BitFenix Prodigy and the Corsair 250D. But they're both constrained by the motherboard itself, which can't do SLI or accommodate extra cards. So, we have to give the edge to **microATX.**

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DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Upgrades and Sidegrades
> TV Tuners
> Missing Boot Managers

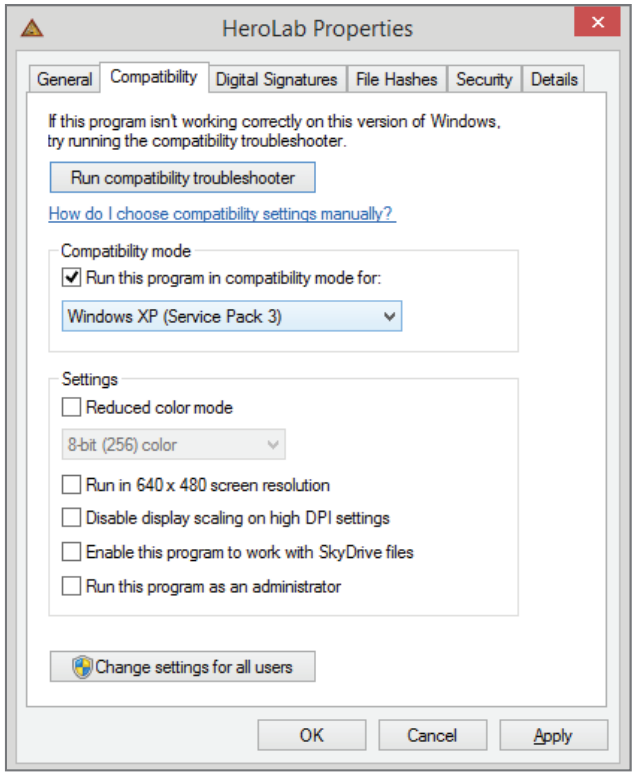
Upgrading to 64-bit

I'm still running a 32-bit Windows XP system, and am looking to upgrade it to Win 7. The computer has an AMD Phenom II X4 965 on a Gigabyte GA-770T-USB3 motherboard that is 64-bit ready, according to Belarc Advisor. I want to go with 64-bit Windows 7, but am at a loss as to what will happen if I try and save all my 32-bit software when I upgrade. When I'm told to save the files I want to keep before transfer, I have to save them as 32-bit files. How do I transfer them to Win 7 as 64-bit? I don't think that can be done, so do I lose all that and have and start over? Can they be run as 32-bit in a 64-bit system? April 8th is coming all too soon and I want to make the change by then, or soon after.

—Bill

THE DOCTOR RESPONDS: Bill, your files should all be fine. You should have no issue with them in a 64-bit version of Windows. As for your programs, without knowing the specific ones you're using, the Doc can't guarantee that they'll run flawlessly, but they should.

Since you can't do an in-place upgrade from 32-bit Windows to 64-bit, you'll have to do a clean install of Windows 7. You will have to reinstall your programs, but they should work just fine once they're reinstalled. Windows is built with a lot of backward compatibility, and should have no problem running your 32-bit programs unless they're very old. If the program doesn't work right away, right-click on the .exe file and select the Compatibility tab. You can select the "run compatibility troubleshooter" button, which will recommend certain compatibility settings, or you can just choose to run in compatibility mode for Windows XP.



Windows' Compatibility tab contains lots of options for running legacy programs in Windows 7 and later.

Before you install Windows 7, you should make sure you have install discs for any programs you can't just re-download from the Internet, and product keys for those that require them. You can use Magical Jellybean Finder (http://bit.ly/MPC_keyfinder) to locate them on your existing computer. You can also take this as a chance to buy an SSD for your upgrade, as well, so you can always fall back and boot from the Windows XP drive if you find you forgot to move a file.

Upgrading a Budget Rig

Back in 2010, I built the $647 PC from the February 2010 issue of *Maximum PC*. It's four years later, and it's about time to get upgrades. Will the Gigabyte GA-MA74GM-S2 mobo from four years ago take PCIe 3.0, or even DDR3 RAM? It isn't covered in the documentation I found and I can barely get any info online. I replaced the ATI card (which died about 6 months ago) with a used Nvidia GTX 570, mostly because I am unsure if a newer video card will work.

—Omega Coriel

THE DOCTOR RESPONDS: The bad news is that your motherboard won't take DDR3; it's

↘ submit your questions to: doctor@maximumpc.com

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a DDR2 board and the two aren't compatible. You'll need a new motherboard and CPU if you want to take advantage of DDR3. It also doesn't have PCIe 3.0 or even PCIe 2.0, but that's less important, since PCI Express is backward compatible—a PCIe 3.0 GPU will run in a PCIe 1.0 slot, just at PCIe 1.0 speeds. TechPowerUp did extensive PCI testing a few years ago (http://bit.ly/1fEskNE) and determined that even a high-end GPU won't be bottlenecked too much running on a PCIe 1.0x16 interface, so you can upgrade to a more powerful GPU and still get around 95 percent of the performance you'd get from it on a newer motherboard.

However, the Doc thinks at this point you may want to invest in a new motherboard and CPU, and maybe an SSD, before you drop too much money on a GPU. The GTX 570 is still a pretty good card, and right now you're probably held back more by your slow CPU and 4GB of RAM, and even your disk access time, than you are by your GPU. You can see how we approached upgrading our AMD rig on page 24 this month, too.

TV Tuners and Linux

I am building my first HTPC using a Zotac IONITX-E-E Mini ITX Atom 230 Motherboard and Arch Linux. I am wondering how a TV tuner works, and if it is a good way to get basic TV channels.

—Asher Rudkin

THE DOCTOR RESPONDS: A tuner card works by taking in a video signal, either from an antenna, cable, or some other source, and allowing you to record it on your computer. A digital tuner in combination with an over-the-air HD antenna will let you use your HTPC as a DVR for your local stations. Since you're using Arch Linux, your best bet for DVR software is MythTV (http://www.mythtv.org). You should refer to the MythTV wiki for tuner and antenna recommendations, as well as setup help.

Storage, Wars

My father is looking to upgrade his computer. He's an enthusiast gamer (mostly 3D strategy, i.e., XCOM, Jagged Alliance, etc.) but also uses the computer for everyday tasks. His biggest complaints are Windows startup times and sometimes sluggish behavior in games. I'm suggesting an Intel Z87-based motherboard with an i5-4XXX series. That has five distinct choices for storage configurations: a 1TB hard drive; a 1TB hybrid drive with 8GB NAND cache; a 1TB hard drive with a 30 or 120GB caching drive via Intel SRT; a 120GB boot SSD (mSATA or SATA) and 1TB HDD; or a RAID 0 boot SSD array and 1TB storage drive. Which would balance boot-up speed, performance, and durability? Looking for best bang for the buck, as we are trying to be as frugal as possible so we can spend more on a GPU.

—Andrew Sullivan

THE DOCTOR RESPONDS: The 120GB boot SSD and 1TB hard drive is the combo the Doc would go with. The 1TB drive will run you about $60 and the SSD around $75. That'll give you the best combination of boot-up speed and all-around performance, since he'll be able to run his OS and his favorite games from the SSD. A hybrid HDD will cost about $85, and it'll help with your boot times, but the Doc would only get that if money is really tight, since you'll mostly see the benefit in boot times and in apps you access regularly. A caching SSD is not worth it, in the Doc's opinion: a 30GB caching SSD will run about $35, and for $40 more you could get a 120GB SSD to run your whole system on. RAID 0 isn't worth it either—bang-for-buck-wise, your best bet is a single boot SSD and a storage hard drive.

AMD, GTX, WTF

I am currently running a system with an AMD FX-8120 Black Edition on a Gigabyte 990FXA-UD3 motherboard. I am looking to upgrade the CrossFire AMD Radeon HD 6770s I am currently using, but a lot of the newer AMD cards have ridiculously inflated price tags compared to similar Nvidia cards, probably due to mining. Will GTX cards work with my processor properly, or should I just suck it up and shell out the $500+ on a HD7900 series card? I mostly use my rig for games like Diablo 3, Starcraft 2, a bunch of games on Steam, and various media-streaming sites.

—Don Clendaniel

THE DOCTOR RESPONDS: An Nvidia card will work fine with your system. While the miners are busy trading their electricity bills for waste heat in pursuit of cryptocoins, there's no sense in buying an AMD card at inflated rates. That said, it looks like prices should be back to normal by the time this column goes to print, as people come to their senses and mining gets harder.

Ivy Bridge-E or Haswell?

I'm building a new PC for video- and large photo–editing, as well as PC gaming. I'm planning on using a 120GB Samsung 840 SSD, 8GB DDR3/2400, and a GeForce GTX 770 GPU. Is it better to use the Asus X79 Deluxe Socket 2011 motherboard and an Ivy Bridge-E Core i7-4820K, or an Asus Maximus VI Extreme with a Haswell i7-4770K?

—Antonios Skoumbouris

THE DOCTOR RESPONDS: The conventional wisdom is to get Ivy Bridge-E for photo- and video-editing and workstation tasks, but that really only makes sense if you need a six-core CPU. The CPUs you're choosing between are both quad-cores and about the same price, so it makes sense to go with the newer architecture and take advantage of more 6Gb/s SATA ports and lower power draw. The Doc would recommend the Haswell part, alongside a cheaper motherboard. The Gigabyte GA-Z87X-UD5H will save you $150 over the Asus Maximus VI Extreme, and that's money you can spend on more RAM and a bigger SSD, both of which will come in handy for video- and photo-editing. The Z87 board will also give you far more native SATA 6Gb/s ports, too.

Missing Boot Manager

A friend of mine had a small business computer that was running Windows 7. His estimating program was kind of pokey, so I gave him an old 120GB OCZ SSD. I used a clone program and installed the SSD. Wow! Amazing difference in speed.

Everything went well, including rebooting, updating etc., until I powered down the computer. When restarted, the drive boot sector was missing. Nothing I could do would correct the problem. If I recopied the HD to the SSD, everything was great once again, until I powered off the computer. Problem occurred again. What did I miss?

—Lew Miller

THE DOCTOR RESPONDS: It sounds like Windows is expecting the Master Boot Record to be elsewhere—perhaps it's still booting from the drive you're cloning from, and so it fails when you remove the hard drive after your install is complete. Whatever the source of the problem, the solution is to rewrite the MBR onto the SSD.

Next time you copy the hard drive over to the SSD, download and install the free version of EasyBCD from http://neosmart.net/EasyBCD before you shut down the computer. You can use this program to rewrite the Windows 7 Master Boot Record. Install and run EasyBCD, then click the "BCD Deployment" button in the left column. Under MBR Configuration Options, select the "Install the Windows Vista/7 bootloader to the MBR," and click the Write MBR button. After the process completes, go to View Settings to make sure it worked correctly.

If you still couldn't boot into Windows, the best way to restore the MBR would be with the repair or install disc for that flavor of Windows. This is much easier.

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UPGRADE YOUR PC

AVOID THE PITFALLS AND UPGRADE LIKE A PRO

BY MAXIMUM PC STAFF

Building a new PC is a relatively easy task—you pick your budget and build around it. It's not the same with upgrading a PC. No, upgrading an older box can be as dangerous as dancing *Footloose*-style through a minefield. Should you really put $500 into this machine, or just buy a new one? Will that new CPU really be faster than your old one in the real world? Are you CPU-limited or GPU-limited?

To help give you more insight on how to best upgrade a PC that is starting to show its age, follow along as we take three real-world boxes and walk you through the steps and decisions that we make as we drag each machine back to the future through smart upgrades. While our upgrade decisions may not be the same ones you would make, we hope that we can shed some light on our thought process for each component, and help you answer the eternal question of: "What should I upgrade?"

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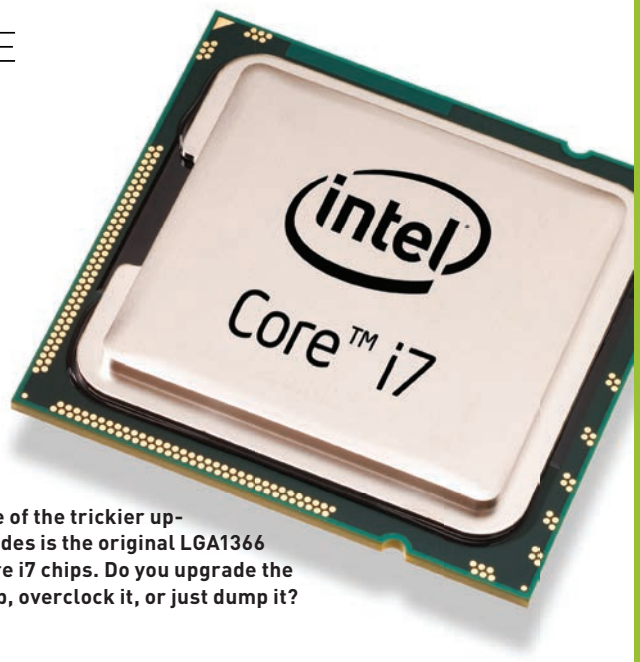
PRACTICAL PC UPGRADING ADVICE

ANYONE CAN UPGRADE, BUT THERE IS A RIGHT WAY AND WRONG WAY

There's really two primary reasons to upgrade. The first is because you can—and believe us, we've upgraded just because "we could" plenty of times. Second, because you need to. How you define "need to" is very much a personal preference—there's no way to put a hard number on it. You can't say, "If I get a 5.11 in BenchMarkMark, I need to upgrade." No, you need to determine your upgrade needs using everyday metrics like, "I will literally throw this PC through a window if this encode takes any longer," or "I have literally aged a year watching my PC boot." And then there's the oldie: "My K/D at Call of Battlefield 5 is horrible because my graphics card is too slow."

Whether or not any of these pain points apply to you, only you can decide. Also, since this article covers very specific upgrades to certain components, we thought we'd begin with some broad tips that are universally applicable when doing the upgrade dance.



One of the trickier upgrades is the original LGA1366 Core i7 chips. Do you upgrade the chip, overclock it, or just dump it?

DON'T FIX WHAT'S NOT BROKEN

One of the easiest mistakes to make with any upgrade plan is to upgrade the wrong component. The best example is someone who decides that his or her PC is "slow," so they need to add RAM and take it from 8GB to 16GB, or even 16GB to 32GB. While there are cases where adding more RAM or higher-clocked RAM will indeed help, the vast majority of applications and games are pretty happy with 8GB. The other classic trap is deciding that a CPU with more cores is needed because the machine is "slow" in games. The truth is, the vast majority of games are coded with no more than four cores in mind. Some newer games, such as Battlefield 4, do indeed run better with Hyper-Threading on a quad-core or a six-core or more processor (in some maps) but most games simply don't need that many cores. The lesson here is that there's a lot of context to every upgrade, so don't just upgrade your CPU willy-nilly on a hunch. Sometimes, in fact, the biggest upgrade you can make is not to upgrade.

CPU-BOUND

You often hear the term "CPU-bound," but not everyone understands the nuances to it. For the most part, you can think of something being CPU-bound when the CPU is causing a performance bottleneck. But what exactly is it about the CPU that is holding you back? Is it core or thread count? Clock speeds, or even microarchitecture efficiency? You'll need to answer these questions before you make any CPU upgrade. When the term is used in association with gaming, "CPU-bound" usually indicates there is a drastic mismatch in GPU power and CPU power. This would be evident from, say, running a GeForce Titan in a system with a Pentium 4. Or say, running a Core i7-4960X with a GeForce 8800GT. These are extreme cases, but certainly, pairing a GeForce Titan or Radeon 290X with a low-end dual-core CPU will mean you would not see the most performance out of your GPU as you could with a more efficient quad-core or more CPU. That's because the GPU depends on the CPU to send it tasks. So, in a CPU-bound scenario, the GPU is waiting around twiddling its thumbs most of the time, since the CPU can't keep up with it.

GPU-BOUND

The situation can be reversed, too. You can indeed get GPU-bound systems by running older or entry-level graphics with a hopped-up CPU. An example could be a Haswell Core i7-4770K overclocked to 4.5GHz paired with say, an entry-level GeForce GTX 750. You will certainly get the best frame rate out of the GPU possible, but you probably did not need the overclocked Haswell to do it. You could have kept that entry-level GPU well-fed with instructions using a cheaper Core i5-4670K or AMD FX part. Still, the rule of thumb with a gaming machine is to invest more in the GPU than the CPU. If we had to make up a ratio though, we'd say your CPU can cost half that of your GPU. A $500 GPU would be good with a $250 CPU and a $300 GPU would probably be OK with a $150–$170 CPU.

YOU CAN IGNORE THE GPU SOMETIMES

Keep in mind, this GPU/CPU relationship is in reference to gaming performance. When it comes to application performance, the careful balance between the two doesn't need to be respected as much, or even at all. For a system that's primarily made for encoding video, photo editing, or other CPU-intensive tasks, you'll generally want as fast a CPU as possible on all fronts. That means a CPU with high clocks, efficient microarchitecture, and as many cores and threads possible will net you the most performance. In fact, in many cases, you can get away with integrated graphics and ignore discrete graphics completely. We don't recommend that approach, though, since GPUs are increasingly becoming important for encoding and even photo editing, and you rarely need to spend into the stratosphere to get great performance. Oftentimes, in fact, older cards will work with applications such as Premiere Pro or Photoshop, while the latest may not, due to drivers and app support from Adobe.

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CORE 2 QUAD BOX

A SMALL FORM FACTOR, LIGHT-GAMING RIG BEFORE SFF WAS POPULAR

This small box has outlived its glory days, but with a modest injection of capital and a few targeted upgrades, we'll whip it back into shape in no time. It won't be able to handle 4K gaming, but it'll be faster than greased lightning and more than capable of 1080p frag-fests.

This particular PC could have very easily resided on the desktop of any *Maximum PC* staffer or reader back in the year 2009. We say that because this is, or was, actually a pretty Kick Ass machine in the day. It was actually a bit ahead of its time, thanks to its combination of benchmark-busting horsepower and small, space-saving dimensions. This mini-rig was probably used for light gaming and content creation, with its powerful CPU and mid-tier GPU. As far as our business here goes, its diminutive size creates some interesting upgrade challenges.

SPECIFICATIONS

	Original part	Upgrade Part	Upgrade Part Cost
Case/PSU	Silverstone SG03/500w	No Change	
CPU	Intel Core 2 Quad QX6800	No change	
Motherboard	Asus P5N7A- VM	No Change	
Cooling	Stock	No Change	
RAM	4GB DDR2/1600 in dual-channel mode	No Change	
GPU	GeForce 9800 GT	EVGA GTX 750 Ti	$159
HDD/SSD	500GB 7,200rpm WD Caviar	240GB OCZ Vertex 460	$159
ODD	DVD burner	No Change	
OS	32-bit Windows Vista Ultimate	No Change	
Misc.		USB 3.0 add-in card	$12
Total upgrade cost			$330

It's built around a Silverstone SG03 mini-tower, which is much shorter and more compact than the SFF boxes we use nowadays. For example, it can only hold about nine inches of GPU, and puts the PSU directly above the CPU region, mandating either a stock cooler or a low-profile job. So, either way, overclocking is very much out of the question. Water-cooling is also a non-starter, due to the lack of space for a radiator either behind the CPU area or on the floor of the chassis. In terms of specs, this system isn't too shabby, as it's rocking an LGA 775 motherboard with a top-shelf Core 2 Quad "Extreme" CPU and an upper-midrange GPU. We'd say it's the almost exact equivalent of a $2,000 SFF gaming rig today. The CPU is a 65nm Kentsfield Core 2 Quad Extreme QX6800, which at the time of its launch was ludicrously expensive and the highest-clocked quad-core CPU available for the Core 2 platform at 2.93GHz. The CPU is plugged into an Asus P5N7A-VM motherboard, which is a microATX model that sports an nForce 730i chipset, supports up to 16GB of RAM, and has one PCIe x1 slot in addition to two PCI slots, and one x16 PCI Express slot. GPU duties are handled by the venerable GeForce 9800 GT, and it's also packing 4GB of DDR2 memory, as well as a 500GB 7,200rpm Western Digital hard drive. Its OS is Windows Vista Ultimate 32-bit.

LETS DIG IN

The first question that crossed our minds when considering this particular machine's fate was, "Upgrade certain parts, or go whole-hog with a new motherboard/CPU/RAM?" Sure, this is *Maximum PC,* and it would be easy to just start over. But that's not really an upgrade; that's more like open-heart surgery. Besides, where's the challenge in that? Anyone can put together a new system, so we decided to buckle down, cinch up our wallets, and go part-by-part.

Starting with the motherboard, CPU, and RAM, we decided to leave those as they were. For Intel at the time, this CPU was as good as it gets, and the only way to upgrade using the same motherboard and chipset is to move to a Yorkfield quad-core CPU. That's a risky upgrade, though, for two reasons. First, not all of those 45nm chips worked in Nvidia's nForce chipset, and second, benchmarks show mostly single-digit percent performance increases over Kentsfield. So, you'd have to be crazy to attempt this upgrade. We also deemed its 4GB of DDR2 to be satisfactory, since we're running a 32-bit OS and anything over 4GB can't be seen by it. If we were running a 64-bit OS, we'd upgrade to 8GB as a baseline amount of memory, though. We're not happy about the motherboard's SATA 3Gb/s ports, and the lack of a x2 PCIe slot is a problem, but SATA 3Gb/s is fast enough to handle any late-model hard drive, or an SSD upgrade. Another problem area is its bounty of 12 USB 2.0 ports. We appreciate the high number of ports, but USB 2.0 just plain sucks, so we added a PCIe USB 3.0 adapter, which gave us four SuperSpeed ports on the back of the chassis.

One area ripe for upgrade is the GPU, because a GeForce 9800 GT is simply weak sauce these days. It was actually a rebadge of the 8800 GT when it arrived in 2009. This GPU was actually considered to be the low-end of the GeForce family when it arrived, as there were two models above it in the product stack—the 9800 GTX and the dual-GPU 9800 GX2. This single-slot GPU was only moderately powered at the time and features 112 shader processors clocked at 1,500MHz, and 512MB of GDDR3 clocked at 1.5GHz on a 256-bit memory bus. Since this system has limited space and only a single six-pin PCIe connector, we decided to upgrade the GPU to the Sapphire Radeon R7 265, which is our choice for the best $150 GPU. Unfortunately, the AMD card did not get along at all with our Nvidia chipset, so we ditched it in favor of the highly clocked and whisper-quiet EVGA GTX 750 Ti, which costs $159. This will not only deliver DX11 gaming at the highest settings at 1080p, but will also significantly lower the sound profile of the system, since this card is as quiet as a mouse breaking wind.

Another must-upgrade part was the 500GB WD hard drive. As we

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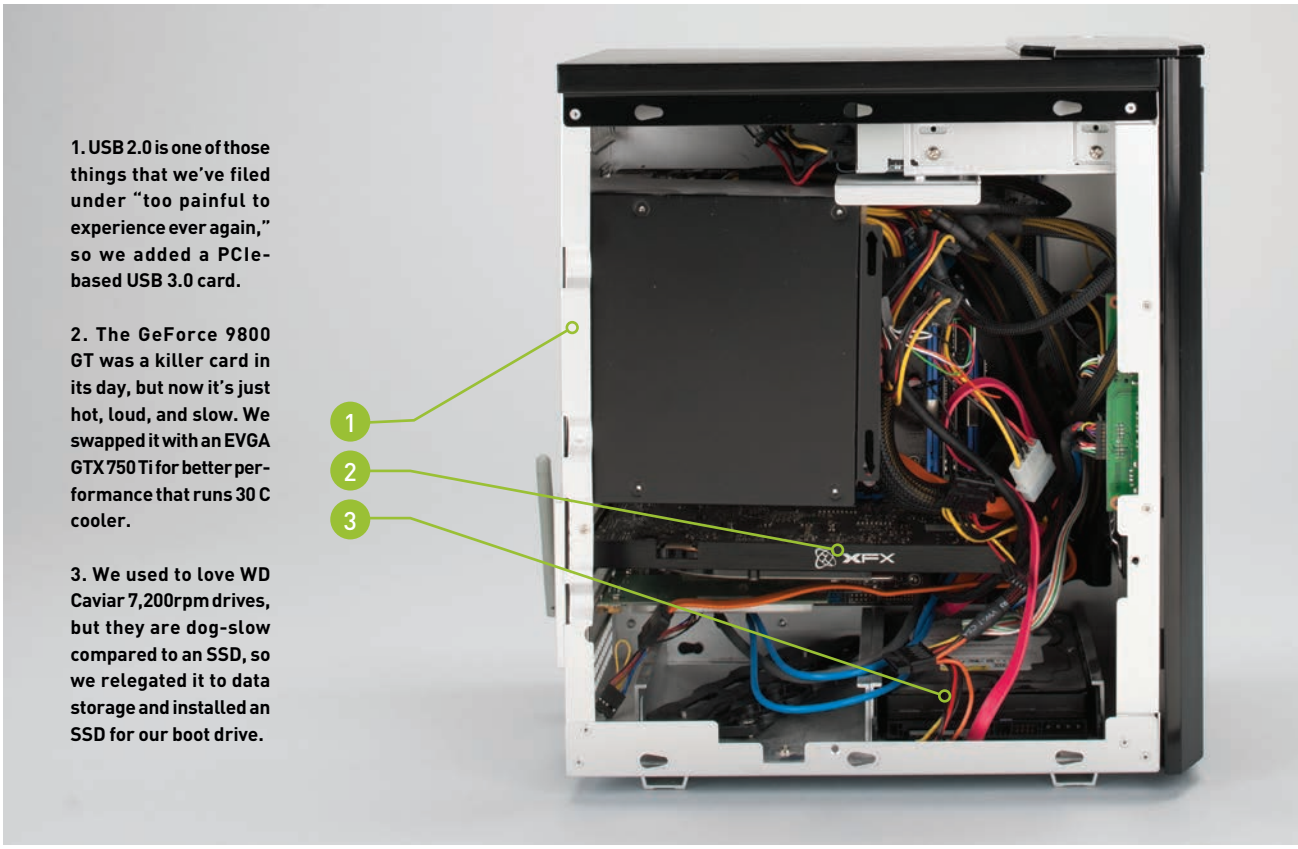

1. USB 2.0 is one of those things that we've filed under "too painful to experience ever again," so we added a PCIe-based USB 3.0 card.

2. The GeForce 9800 GT was a killer card in its day, but now it's just hot, loud, and slow. We swapped it with an EVGA GTX 750 Ti for better performance that runs 30 C cooler.

3. We used to love WD Caviar 7,200rpm drives, but they are dog-slow compared to an SSD, so we relegated it to data storage and installed an SSD for our boot drive.

wrote elsewhere, an SSD is a must-have in any modern PC, and we always figured it could make an aging system feel like new again, so this was our chance to try it in the real world. Though we wanted to upgrade to a 120GB Samsung 840 EVO, we couldn't get our hands on one, so we settled for a larger and admittedly extravagant OCZ Vertex 460 240GB for $160. We decided to leave the OS as-is. Despite all the smack talk it received, Windows Vista SP2 was just fine.

REAL-WORLD RESULTS

Since we upgraded the GPU and storage subsystem, we'll start with those results first. With the SSD humming along, our boot time was sliced from 1:27 to 1:00 flat, which is still a bit sluggish but doesn't tell the whole story. Windows Vista felt instantly "snappy," thanks to the SSD's lightning-fast seek times. Everything felt fast and responsive, so though we didn't get a sub-20-second boot time like we thought we would, we still gained a very noticeable increase in day-to-day use of the machine. For the record, we blame the slow boot time on the motherboard or something with this install of Vista, but this is still an upgrade we'd recommend to anyone in a similar situation. Interestingly, we also saw a boost in one of our encoding benchmarks, which could be due to the disk I/O, as well. For example, Sticth.Efx 2.0 dropped from 41 minutes to 36 minutes, which is phenomenal. Stitch.Efx creates in excess of 20,000 files, which will put a drag on a 500GB hard drive.

Our gaming performance exploded, though, going from 11fps in Heaven 4.0 to 42fps. In Batman: Arkham Origins, we went from a non-playable 22 fps to a smooth 56fps, so anyone who thinks you need a modern CPU for good gaming performance is mistaken (at least for some games); the GPU does most of the heavy lifting in gaming. We also got a major reduction in case temps and noise by going from the hot-and-loud 9800 GT to the silent-and-cool GTX 750 Ti. The old card ran at 83 C under load, while the new one only hit 53 C, and made no noise whatsoever.

NO REGRETS

Since we couldn't do much with the motherboard/CPU/RAM on this board without starting fresh, we upgraded what we could and achieved Kick Ass real-world results from it, so this operation upgrade was very successful. Not only does it boot faster and feel ultra-responsive, it's also ready for at least another year of gaming, thanks to its new GPU. Plus, with USB 3.0 added for storage duties, we can attach our external drives and USB keys and expect modern performance. All-in-all, this rig has been given a new lease on life for just a couple hundies—not bad for a five-year-old machine.

BENCHMARKS

	PRE-UPGRADE	
Cinebench R15 64-bit	WNR	WNR
ProShow Producer 5.0 (sec)	3,060	3,334 (-8%)
Stitch.Efx (sec)	2,481	2,166
Bootracer (sec)	90	60
Batman: Arkham Origins (fps)	22	56 (+155%)
Heaven 4.0 (fps)	11	42 (+282%)

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SKELETON RISES

FLYING THE AMD FLAG

Our second rig flies the AMD "Don't Underclock Me" flag. You know the type. No matter how wide a gap Intel opens up with its latest CPU techno-wonder, this AMD CPU fanboy won't switch until you pry that AM3 CPU from his cold, dead motherboard. In fact, the bigger the performance gap with Intel, the deeper this fanboy will dig in his heels.

The box itself is built around the eye-catching and now discontinued Antec Skeleton open-air chassis. It draws a lot of whistles from case aficionados when they walk by, but truth be told, it's really not great to work in and not exactly friendly to upgrading. The base machine parts are pretty respectable, though. The mainboard is an Asus Crosshair IV (CHIV) Formula using the AMD 890FX chipset, with a quad-core 3.2GHz Phenom II X4 955 and GeForce GTX 570 graphics. For the record, this machine was not built by us, nor do we know who built it, but the original builder made the typical error of inserting the pair of 2GB DDR3/1066 DIMMs into the same channel memory slots, causing the sticks to run in single-channel mode instead of dual-channel. As any salty builder knows, there's a reason the phrase "RTFM" exists. For storage, the machine packs a single 1TB 7,200rpm hard drive and a DVD burner. Power is handled by an AntecTruePower 750, which is plenty for a rig like this. Cooling is a stock AMD affair with dual heat pipes.

SPECIFICATIONS

	Original part	Upgrade Part	Upgrade Part Cost
Case/PSU	Antec Skeleton / TruePower 750	No Change	
CPU	3.2GHz Phenom II X4 955	4GHz FX-8350 Black Edition	$199
Motherboard	Asus Crosshair IV Formula	No Change	
Cooling	Stock	No Change	
RAM	4GB DDR3/1066 in single-channel mode	8GB DDR3/1600 in dual-channel mode	$40
GPU	EVGA GeForce GTX 570 HD	Asus GTX760-DC2OC-2GD5	$259
HDD/SSD	1TB 7,200 Hitachi	256GB Sandisk Ultra	$159
ODD	DVD burner	No Change	
OS	64-bit Windows 7 Pro	No Change	
Total upgrade cost			$657

THE EASY UPGRADE PATH

All in all, it's not a bad PC, but the most obvious upgrade was storage. It's been a long time since we used a machine with a hard drive as the primary boot device, and having to experience it once again was simply torture. We're not saying we don't love hard drives—it's great to have 5TB of space so you never have to think about whether you have room to save that ISO or not—just not as the primary boot device. Our first choice for an upgrade was a 256GB Sandisk Ultra Plus SSD for $159. We thought about skimping for the 128GB version, but then figured it's worth the extra $60 to double the capacity—living on 128GB is difficult in this day and age. The SSD could easily be moved to a new machine, too, as it's not tied to the platform.

The OS is 64-bit Windows 7 Pro, so there's no need to "upgrade" to Windows 8.1. No, we'd rather put that $119 into the two other areas that need to be touched up. The GPU, again, is the GeForce GTX 570. Not a bad card in its day, but since the Skeleton's current owner does fair bit of gaming, we decided it was worth it to invest in a GPU upgrade. We considered various options, from the GeForce GTX 770 to a midrange Radeon R9 card, but felt a GeForce GTX 760 was the right fit, considering the system's specs. It simply felt exorbitant to put a $500 GPU into this rig. Even the GTX 770 at $340 didn't feel right, but the Asus GTX760-DC2OC-2GD5 gives us all the latest Nvidia technologies, such as ShadowPlay. The card is also dead silent under heavy loads.

Our next choice was riskier. We definitely wanted more performance out of the 3.2GHz Phenom II X4 955 using the old "Deneb" cores. The options included adding more cores by going to a 3.3GHz Phenom II X6 1100T Thuban, but all we'd get is two more cores and a marginal increase in clock speed. Since the Thuban and Deneb are so closely related, there would be very little to be gained in microarchitecture upgrades. X6 parts can't be found new, and they fetch $250 or more on eBay. As any old upgrading salt knows, you need to check the motherboard's list of supported chips before you plug in. The board has an AM3 socket, but just because it fits doesn't mean it works, right? Asus' website indicates it supports the 3.6GHz FX-8150 "Zambezi" using the newer Bulldozer core, but the Bulldozer didn't exactly blow us away when launched and they're also out of circulation. (Interestingly, the FX-8150 sells for less than the Phenom II X6 chips.) Upgrading the motherboard was simply out of the question, too. Our last option was the most controversial. As we said, you should always check the motherboard maker first to find out what chips are supported.

After that, you should then check to see if some other adventurous user has tried to do it anyway: "Damn the CPU qual list, full upgrade ahead!" To our surprise, yes, several anonymous Internet forums have indeed dropped the 4GHz FX-8350 "Vishera" into their CHIV boards with no reported of issues. That FX-8350 is also only $199—cheaper than a used X6 part. We considered overclocking the part, but the Skeleton's confines make it pretty difficult. It's so tight that we had issues putting the GeForce GTX 760 in it, so using anything larger than the stock cooler didn't make sense to us. We're sure you can find a cooler that fit, but nothing that small would let us overclock by any good measure, so it didn't seem prudent.

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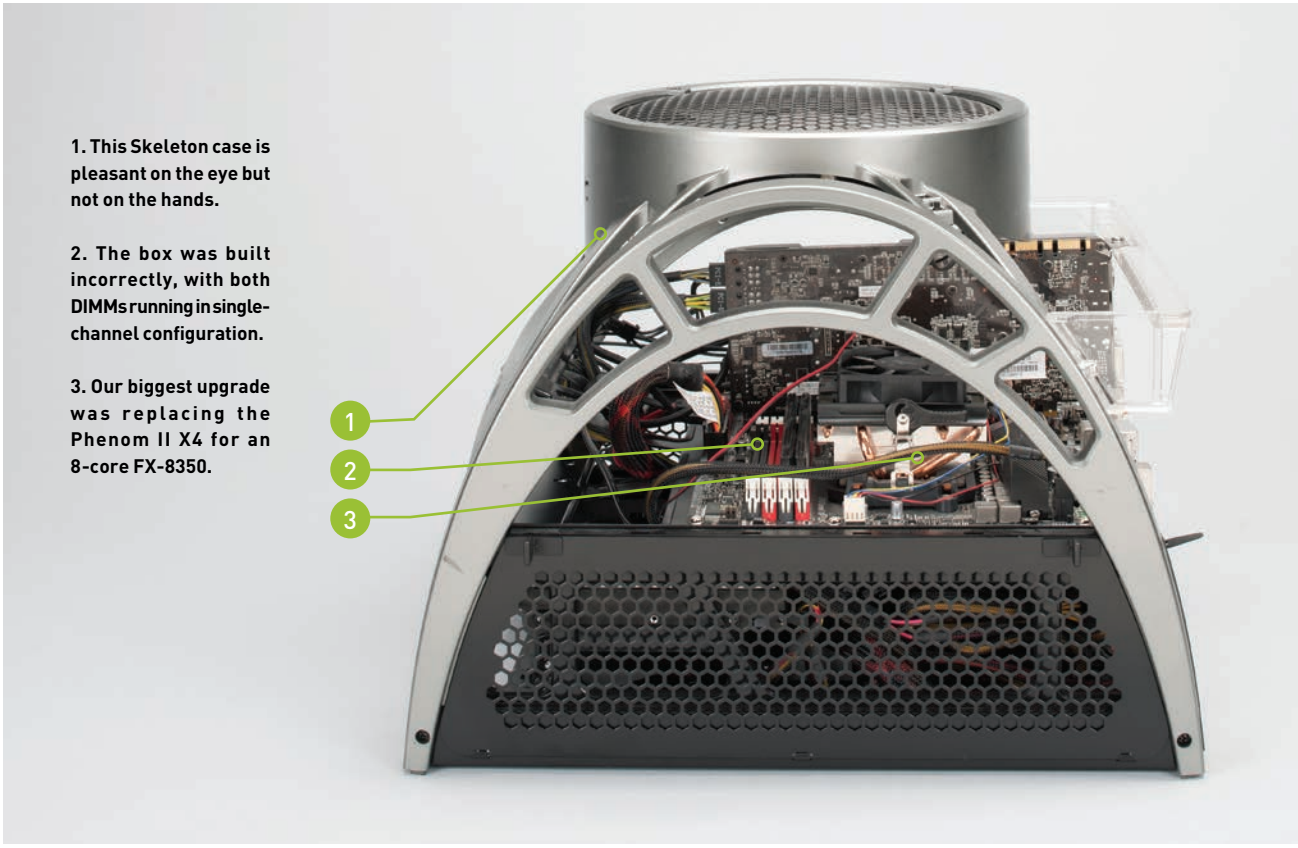

1. This Skeleton case is pleasant on the eye but not on the hands.

2. The box was built incorrectly, with both DIMMs running in single-channel configuration.

3. Our biggest upgrade was replacing the Phenom II X4 for an 8-core FX-8350.

WAS IT WORTH IT?

Let's just say this again if it's not clear to you: If you are running a hard drive as your boot device, put this magazine down and run to the nearest store to buy an SSD. Yes, hard drives are that slow compared to SSDs. In fact, if we had money for only one upgrade, it would be the SSD, which will make an old, slow machine feel young again. This machine, for example, would boot to the desktop in about 38 seconds. With the SSD, that was cut down to 15 seconds and general usability was increased by maybe 10 million percent.

Our CPU upgrade paid off well, too. AMD's Vishera FX-8350 offers higher clock speeds and significant improvements in video encoding and transcoding. We saw an 83 percent improvement in encoding performance. The eight cores offer a huge advantage in thread-heavy 3D modelling, as well. We didn't get the greatest improvement with Stitch.Efx 2.0, but the app is very single-threaded initially. Still, we saw a 30 percent increase, which is nothing to sneeze at.

In gaming, we were actually a bit disappointed with our results, but perhaps we expected too much. We tested using Batman: Arkham Origins at 1080P with every setting maxed out and saw about a 40 percent boost in frame rates. Running Heaven 4.0 at 1080P on max we also saw about a 42 percent increase in frame rate. Again, good. But for some reason, we expected more.

REGRETS, I'VE HAD A FEW

PC upgrades can turn into a remorsefest or an inability to face the fact that you made the wrong choice. With our upgrades, we were generally pleased. While some might question the CPU upgrade (why not just overclock that X4?), we can tell you that no overclock would get you close to the FX-8350 upgrade in overall performance. The SSD upgrade can't be questioned. Period. End of story. The difference in responsiveness with the SSD over the 1TB HDD is that drastic.

When it comes to the GPU upgrade, though, we kind of wonder if we didn't go far enough. Sure, a 40 percent performance difference is the difference between playable and non-playable frame rates, but we really wanted to hit the solid 50 percent to 60 percent mark. That may simply be asking too much of a two-generation GPU change, not going all the way to the GeForce GTX 570's spiritual replacement: the GeForce GTX 770. That would actually put us closer to our rule of thumb on a gaming rig of spending about half on your CPU as your GPU, but the machine's primary purpose isn't just gaming, it's also content creation.

BENCHMARKS

	PRE-UPGRADE	
Cinebench R15	326	641
ProShow Producer 5.0 (sec)	3,276	1,794
Stitch.Efx (sec)	1,950	1,500
Bootracer (sec)	37.9	15 (+153%)
Batman: Arkham Origins (fps)	58	81
Heaven 4.0 (fps)	29.5	41.9

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ONE DUSTY NEHALEM

THE ORIGINAL CORE I7 STILL HAS SOME JUICE

It's easy to make upgrade choices on an old dog with AGP graphics and Pentium 4, or even a Core 2 Duo on an obsolete VIA P4M890 motherboard (yes, it exists, look it up.) When you get to hardware that's still reasonably fast and relatively "powerful," the upgrade choices you have to make can get quite torturous.

That's certainly the case with this PC, which has an interesting assortment of old but not obsolete parts inside the Cooler Master HAF 922 case. We've always been fans of the HAF series, and despite being just plain-old steel, the case has some striking lines. It does, however, suffer from a serious case of dust suckage. Between the giant fan in front and various other fans, this system was chock-full of the stuff.

The CPU is the first-generation Core i7-965 with a base clock of 3.2GHz and a Turbo Boost of 3.46GHz. That may seem like a pretty mild Turbo, but that's the way it was way back in 2008, when this chip was first released. It's plugged into an Asus Rampage II Extreme motherboard using the X58 chipset, and running 6GB of DDR3/1600 in triple-channel mode.

In graphics, it's also packing some heat with the three-year-old GeForce GTX 590 card. For those who don't remember it, the card has two GPU cores that basically equal a pair of GeForce GTX 570 cards in SLI. There was a secondary 1TB drive in the machine, but in the state we got it, it was still using it's primary boot device—a 300GB Western Digital Raptor 10,000rpm hard drive that was 95 percent stuffed with data. Oh, and the OS is also quite vintage, with 64-bit Windows Vista Ultimate.

SPECIFICATIONS

	Original part	Upgrade Part	Upgrade Part Cost
Case/PSU	Cooler Master HAF 922 / PC Power and Cooling 910	No Change	
CPU	3.2GHz Core i7-965 Extreme Edition	No Change	
Motherboard	Asus Rampage II Extreme	No Change	
Cooling	Stock	Corsair Hydro Cooler H75	$69
RAM	6GB DDR3/1600 in dual-channel mode	No Change	
GPU	GeForce GTX 590	No Change	
SSD/HDD	300GB 10,000rpm WD Raptor, 1TB 7,200rpm Hitachi	256GB Sandisk Ultra	$159
ODD	Lite-On Blu-Ray burner	No Change	
OS	64-bit Windows Vista Ultimate	No Change	
Misc.		USB 3.0 add-in card	$12
Total upgrade cost			$277

ALWAYS BE UPGRADING THE SSD

Our first upgrade decision was easy—SSD. In its day, the 300GB Raptor was the drive to have for its performance, but with the drive running at 90 percent of its capacity, this sucker was beyond slow. Boot time on the well lived-in Vista install was just over two minutes. Yes, a two-minute boot time. By moving to an SSD and demoting the Raptor to secondary storage, the machine would see an immediate benefit in responsiveness. For most people who don't actually stress the CPU or GPU, an SSD upgrade is actually a better upgrade than buying a completely new machine. And yes, we fully realize the X58 doesn't have support for SATA 6Gb/s, but the access time of the SSD and pretty much constant read and writes at full bus speed will still make a huge difference in responsiveness.

The real conundrum was the CPU. As we said, this is the original Core i7, a quad-core chip with Hyper-Threading and support for triple-channel RAM. The CPU's base clock is 3.2GHz. It is an unlocked part, but the chip is sporting a stock 130W TDP Intel cooler. Believe it or not, this is actually how some people build their rigs—they buy the overclocked part but don't overclock until later on, when they need more performance. Well, we're at that point now, but we knew we weren't going very far with a stock Intel cooler, so we decided that this was the time to introduce a closed-loop liquid cooler in the form of a Corsair H75. Our intention was to simply overclock and call it a day, but when we saw some of the performance coming out of the AMD Skeleton on page 33, we got a little jealous. In two of our tests for this upgrade story, the AMD FX-8350 was eating the once-mighty Nehalem's lunch. Would overclocking be enough? That got us wondering if maybe we should take the LGA1366 to its next-logical conclusion: the Core i7-970. The Core i7-970 boasted six cores with Hyper-Threading for a total of 12 threads. It has the same base clock of 3.2GHz and same Turbo Boost of 3.46GH, but it uses the newer and faster 32nm "Westmere" cores. Long since discontinued, it's easy to find the chips used for about $300, which is about half its original price. This is that conundrum we spoke of—while the Westmere would indeed be faster, especially on thread-heavy tasks such as video encoding and 3D modeling, do we really want to spend $300 on a used CPU? That much money would almost get us a Core i7-4770K, which would offer far more performance in more apps. Of course, we'd have to buy a new board for that, too. In the end, we got cold feet and decided to stick with just an overclock.

WINDOWS VISTA WORKS

Even our OS choice had us tied up. There's a reason Windows Vista was a hated OS when it was released. It was buggy, slow, and drivers for it stunk. For the most part, though, Windows Vista turned into a usable OS once Service Pack 1 was released, and Service Pack 2 made it even better. While we'd never buy Vista over Windows 7 today, it's actually functional, and the performance difference isn't as big as many believe it to be, when it's on a faster system. The only real shortcoming of Windows Vista is the lack of trim support for the SSD.

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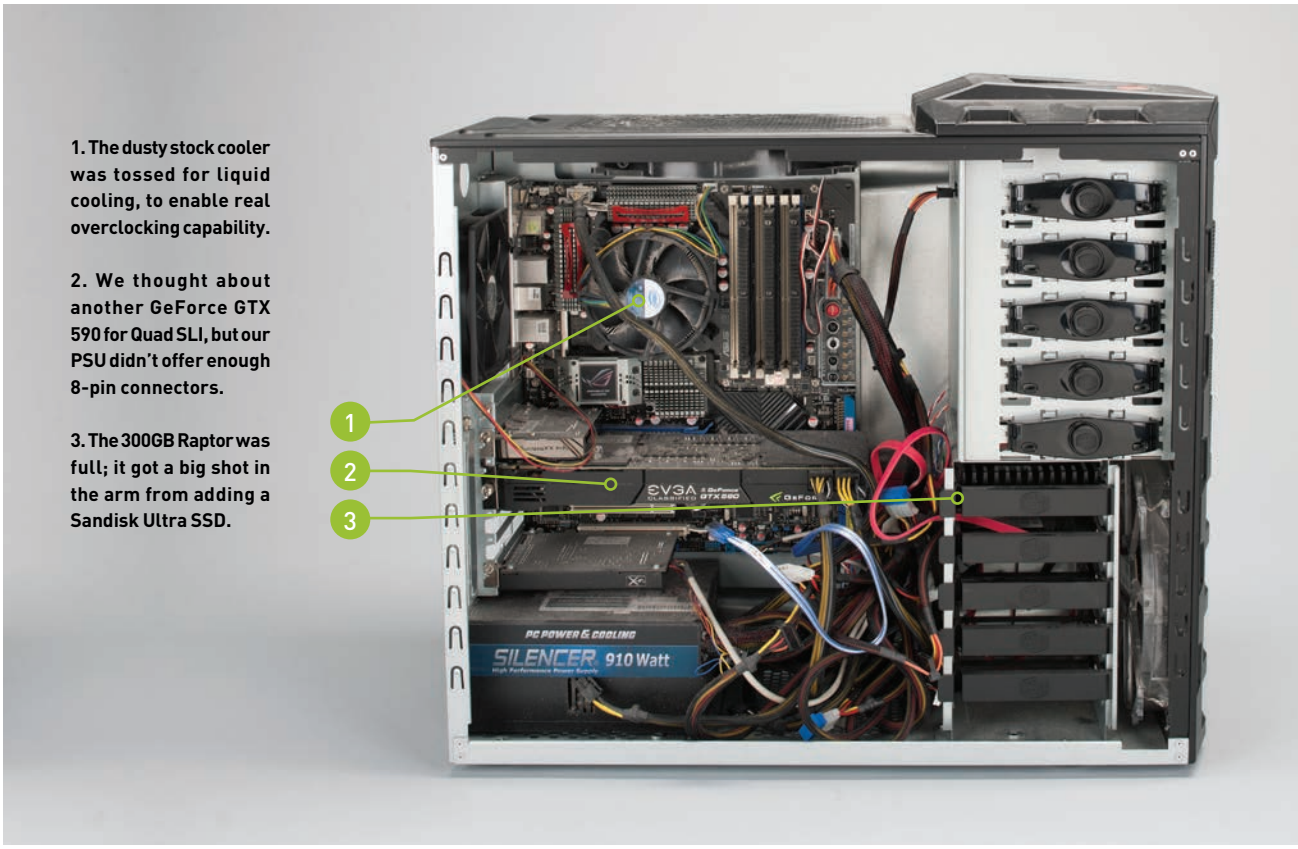

1. The dusty stock cooler was tossed for liquid cooling, to enable real overclocking capability.

2. We thought about another GeForce GTX 590 for Quad SLI, but our PSU didn't offer enough 8-pin connectors.

3. The 300GB Raptor was full; it got a big shot in the arm from adding a Sandisk Ultra SSD.

That means the build would have to have the SSD manually optimized using the drive's utility, or we'd have to count on its garbage collection routines. For now, we'd rather put the $119 in the bank toward the next system build with, perhaps, Windows 9.

Even more difficult was our choice on the GPU. The GeForce GTX 590 was a top-of-the-line card and sold for $700 in 2011. Obviously, this card was put into the system after the box was initially built, so it has had one previous upgrade. In looking at our upgrade options, our first thought was to go for something crazy—such as a second GTX 590 card. They can be found used for about $300. That would give the machine Quad SLI performance at far less the cost of a newer top-tier GPU. That fantasy went up in smoke when we realized the PC Power and Cooling Silencer 910 had but two 8-pin GPU power connectors and we'd need a total of four to run Quad SLI. Buying another expensive PSU just to run Quad SLI just didn't make sense in the grand scheme of things, since the PSU is perfectly functional and even still under warranty. Once the second GTX 590 was ruled out, we considered a GeForce GTX 780 Ti as an option. While the 780 Ti is a beast, we came to the realization that the GTX 590 honestly still has plenty of legs left, especially for gaming at 1080p. The 780 Ti is indeed faster by 20 to 50 percent, but we decided not to go that route, as the machine still produces very passable frame rates. In the end, we spent far less upgrading this machine than the other two. But perhaps that makes sense, as its components are much newer and faster than the other two boxes.

POST-UPGRADE PERFORMANCE

With our only upgrades on this box being an overclock and an SSD, we didn't expect too much—but we were pleasantly surprised. Our mild overclock took the part to 4GHz full-time. That's 800MHz over the base clock speed. In Cinebench R15, the clock speed increase mapped pretty closely to the performance difference. In both ProShow Producer and Stitch.Efx, though, we actually saw greater performance than the simple overclock can explain. We actually attribute the better performance to the SSD. While encoding tasks are typically CPU-bound, disk I/O can make a difference. Stitch.Efx also spits out something on the order 20,000 files while it creates the gigapixel image. The SSD, of course, made a huge difference in boot times and system responsiveness, even if it wasn't on a SATA 6Gb/s port.

REGRETS

Overall, we were happy with our upgrade choices, with the only gnawing concern being not upgrading the GPU. It just ate us up knowing we could have seen even better frame rates by going to the GTX 780 Ti. But then, we also have $750 in our pocket that can go toward the next big thing.

BENCHMARKS

	PRE-UPGRADE	
Cinebench R15	515	617
ProShow Producer 5.0 (sec)	2,119	1,641
Stitch.Efx (sec)	1,446	983
Bootracer (sec)	126	18 (+600%)
Batman: Arkham Origins (fps)	86	87
Heaven 4.0 (fps)	68.2	68.7

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

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HOW TO UPGRADE FROM WINDOWS XP

IT'S GAME OVER, MAN!

Stick a fork in it. It's done. Finito. Windows XP is a stiff. Bereft of life, it rests in peace... on a considerable number of desktops worldwide, much to Microsoft's chagrin.

You've read Microsoft's early-2012 announcement. You've seen all the news since then: the warnings, the pleas, the tomes of comments from frustrated users who wish they could just have a fully supported Windows XP until the launch of Windows 20. If you were a holdout, you even got a few pop-ups directly in your operating system from Microsoft itself, imploring you to switch on up to a more powerful (re: supported) version of Windows. So says Microsoft:

"If you continue to use Windows XP after support ends, your computer should still work, but it will become five times more vulnerable to security risks and viruses. And as more software and hardware manufacturers continue to optimize for more recent versions of Windows, a greater number of programs and devices like cameras and printers won't work with Windows XP."

There you have it: Keep on keepin' on with Windows XP and you'll slowly enter the wild, wild west of computing. We can't say that your computer is going to be immediately infected once you reach a set time period past what's been chiseled on the operating system's tombstone. However, the odds of you suffering an attack that Microsoft has no actual fix for certainly increase. You wouldn't run a modern operating system without the latest security patches; why Windows XP?

So, what's a person to do? Upgrade, obviously. We do warn in advance that if your current Windows XP machine is chock-full of legacy apps (or you're using more antiquated hardware like, dare we say it, a printer attached to a parallel port), then you might find that upgrading to a newer version of the OS ruins the experience you previously had. For that, we can only suggest taking advantage of the ability of newer versions of Windows to support virtualized Windows XP environments—Windows 7 supports the Virtual PC–based "Windows XP Mode" natively, whereas those on Windows 8 can benefit from freeware like Virtualbox to run a free, Microsoft-hosted download of a virtualized Windows XP.

As for what you should upgrade to, and how, we're recommending that you go with Windows 8—unless you can find Windows 7 for extremely cheap. Microsoft has greatly improved resource use in its flagship OS, in addition to streamlining startup times, adding more personalization, and beefing up security. Windows 8 has far more time before its end-of-life than Windows 7, even though, yes, you'll have to deal with the Modern UI a bit when you make your upgrade.

INSTALLATION PATHS TO WINDOWS 8

The process of upgrading to new versions of operating systems can be a bit maddening, assuming you don't just want to blank your system and perform a clean installation with each and every go-around (we do; you might prefer not to).

Thankfully, Microsoft has laid out all of your options on a "Windows 8 and Windows 8.1 Upgrade Paths" TechNet post. Assuming you're upgrading to straight ol' Windows 8, here's a handy chart showing what you can do.

As you'll see, the only real way to preserve your settings, files, and installed applications is to jump from Windows 7 to Windows 8. Most Windows operating systems since XP will allow you to keep your personal files (those found in your specific "Users" folders, or "Documents and Settings" on the older Windows XP). Doing so involves the operating system creating a "windows.old" file on your hard drive within your new operating system, where you'll find all of the data that migrated.

Obviously, jumping from a 32-bit to a 64-bit OS is as clean an installation as one can be. You'll get no options to save anything.

	Keep Windows settings, personal files, and applications	Keep Windows settings and personal files (data and system settings)	Keep personal files only (data only)	Keep nothing
Windows XP (SP3 or later)	No	No	Yes	Yes
Windows Vista	No	No	Yes	Yes
Windows Vista with SP1	No	Yes	Yes	Yes
Cross-architecture installation (32-bit to 64-bit) Windows Vista with SP1 or later	No	No	No	No
Cross-language Windows Vista with SP1 or later	No	No	Yes	Yes
Windows 7	Yes	No	Yes	Yes
Cross-architecture installation (32-bit to 64-bit) Windows 7	No	No	No	No
Windows 8	Yes	No	Yes	Yes
Cross-architecture installation (32-bit to 64-bit) Windows 8	No	No	No	No

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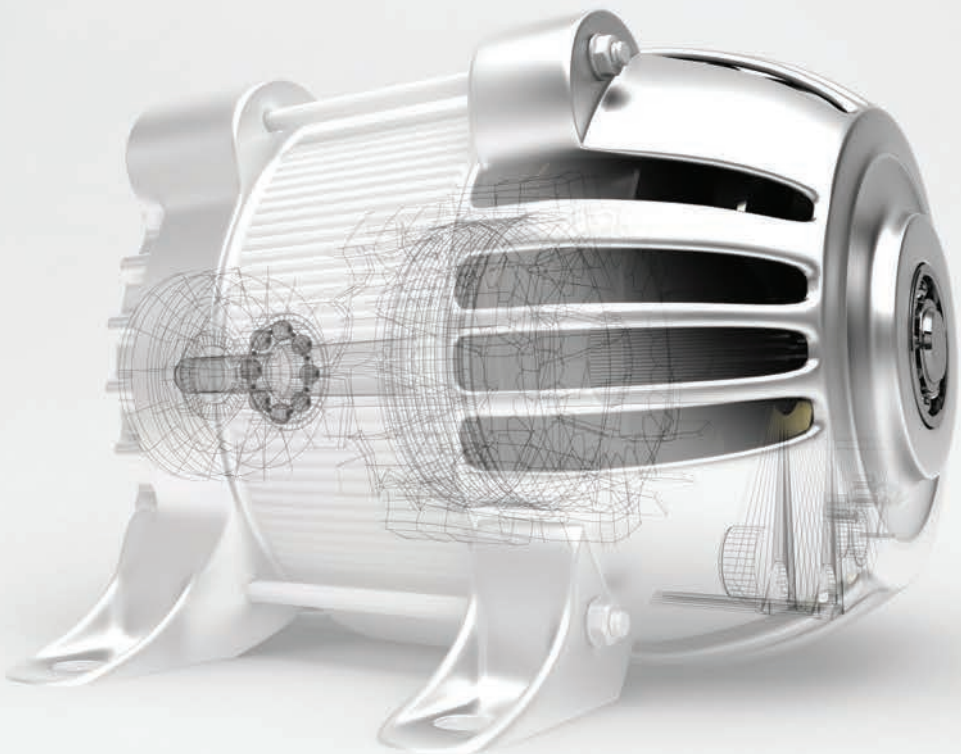

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STEP-BY-STEP UPGRADE GUIDE

ANYONE CAN UPGRADE, BUT THERE IS A RIGHT WAY AND WRONG

Windows 7 Upgrade Advisor
32-bit report
64-bit report
Number of issues found you may need to address: 1
Save Repo
System
Details
Custom installation required
You'll need to perform a custom installation of 32-bit Windows 7 and then reinstall your programs. Ma
sure to back up your files before you begin.
Go online to get important information about installing Windows 7 on a PC running Windows XP
512 MB of RAM
Your PC needs at least 1 GB of RAM for 32-bit Windows 7 for optimal performance. Contact your PC
manufacturer or retailer to see if an upgrade is available.
Outlook Express
This program is no longer included in Windows 7. You can get similar programs for Windows 7 from o
software manufacturers.
Go to the Microsoft website to learn more
3 system requirements passed
See all system requirements
Devices
Status
Details
VMware Accelerated AMD PCNet Adapter
VMware, Inc.
Unknown
We don't have compatibility information about this device.
Creative AudioPCI (ES1371,ES1373) (WDM)
Check Windows Update
Check Windows Update after installing Windows 7 to make sure you have the latest driver for this
device, otherwise it may not work.

The Windows 7 Upgrade Advisor is a bit more useful than the Windows 8 Upgrade Assistant in terms of actionable items that you'll want to know about. Doesn't hurt to run both!

Will your legacy system even run a modern version of Windows? That's the first thing you're going to want to check before you start walking down the XP-to-8 upgrade path. Microsoft has released two different tools to help you out—only one of them works for Windows XP, however. Hit up Microsoft's site and do a search for "Windows 8 Upgrade Assistant." Download that, install it on your Windows XP machine, and run the application.

After a (hopefully) quick scan of your system, the program will report back the number of apps and devices you're using that are compatible with Windows 8. In a perfect world, that would be all of them. However, the tool will also report back fatal flaws that might prevent you from running Windows 8 on your Windows XP machine to begin with—like, for example, if your older motherboard and CPU don't support the Windows 8–required Data Execution Prevention.

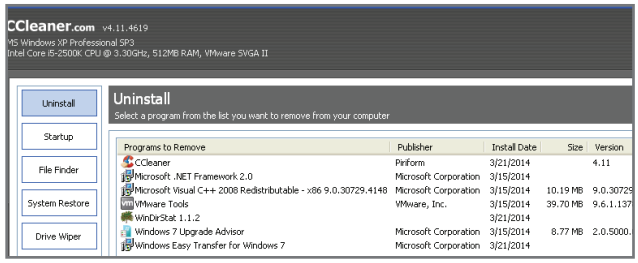
Since Windows 8 is quite a bit removed, generation-wise, from Windows XP, there's no means by which you can simply run an in-place upgrade that preserves your settings and installed applications. Personal files, yes, but now's as good a time as any to get your data organized prior to the big jump—no need to have Windows 8 muck things up for you, as it will just create a "windows.old" folder that's a dump of the "Documents and Settings" folders on your XP system.

If you have a spare hard drive lying around, you could always clone your current disk using a freeware app like Clonezilla, install Windows 8 on your old drive, and sort through everything later. If not, then you're going to want to grab some kind of portable storage—or, barring that, sign up for a cloud-based storage service—and begin the semi-arduous task of poring over your hard drive for all of your important information.

The Windows Easy Transfer app, downloadable from Microsoft, helps automate the otherwise manual process of copying your files from your XP machine to portable storage.

There really isn't a great tool that can help you out in this regard, except perhaps WinDirStat—and that's only assuming that you've stored chunks of your important data in key areas around your hard drive. If worse comes to worse, you could always back up the entire contents of your "Documents and Settings" folder, just to be safe. It's unlikely that you'll have much critical data in Program Files or Windows but, again, it all depends on what you've been doing on your PC. Gamers eager to make sure that their precious save files have been preserved can check out the freeware GameSave Manager to back up their progress.

As for your apps, you're going to have to reinstall those. You can, however, simplify this process by using a tool like Ninite to quickly and easily install common apps. CCleaner, when installed on your old XP system, can generate a list of all the apps that you've previously installed within the operating system—handy for making a checklist for things you'll want to reinstall later, we suppose. And



Need to know what you'll need to reinstall in Windows 8? Use CCleaner to make a simple text file of every app you installed on Windows XP, and check off as you go!

finally, an app like Magical Jelly Bean's Product Key Finder can help you recover old installation keys for apps that you might want to reinstall within Windows 8.

As for installing Windows 8, we recommend that you purchase and download the ISO version of the operating system and then use Microsoft's handy Windows 7 USB/DVD Download Tool to dump the contents of that ISO onto a portable flash drive. Your installation process will go much faster, trust us. From there, installing the OS is as easy as inserting your USB storage, resetting your computer, and booting from the flash drive—which might be accessible via some "boot manager" option during your system's POST, or might be a boot order–related setting that you have to set up within the BIOS itself.

Other than that, the installation process is fairly straightforward once Windows 8 gets going. You'll enter your product key, select a Custom installation, delete or format your drive partitions, install Windows 8 on the new chunk of blank, empty storage, and sit back and relax while the fairly simple installation process chugs away.

You might not have the speediest of operating systems once Windows 8 loads, depending on just how long your Windows XP machine has been sitting around, but at least you'll be a bit more secure! And, hey, now that you have a license key, you can always upgrade your ancient system (or build a new one!) and reinstall.

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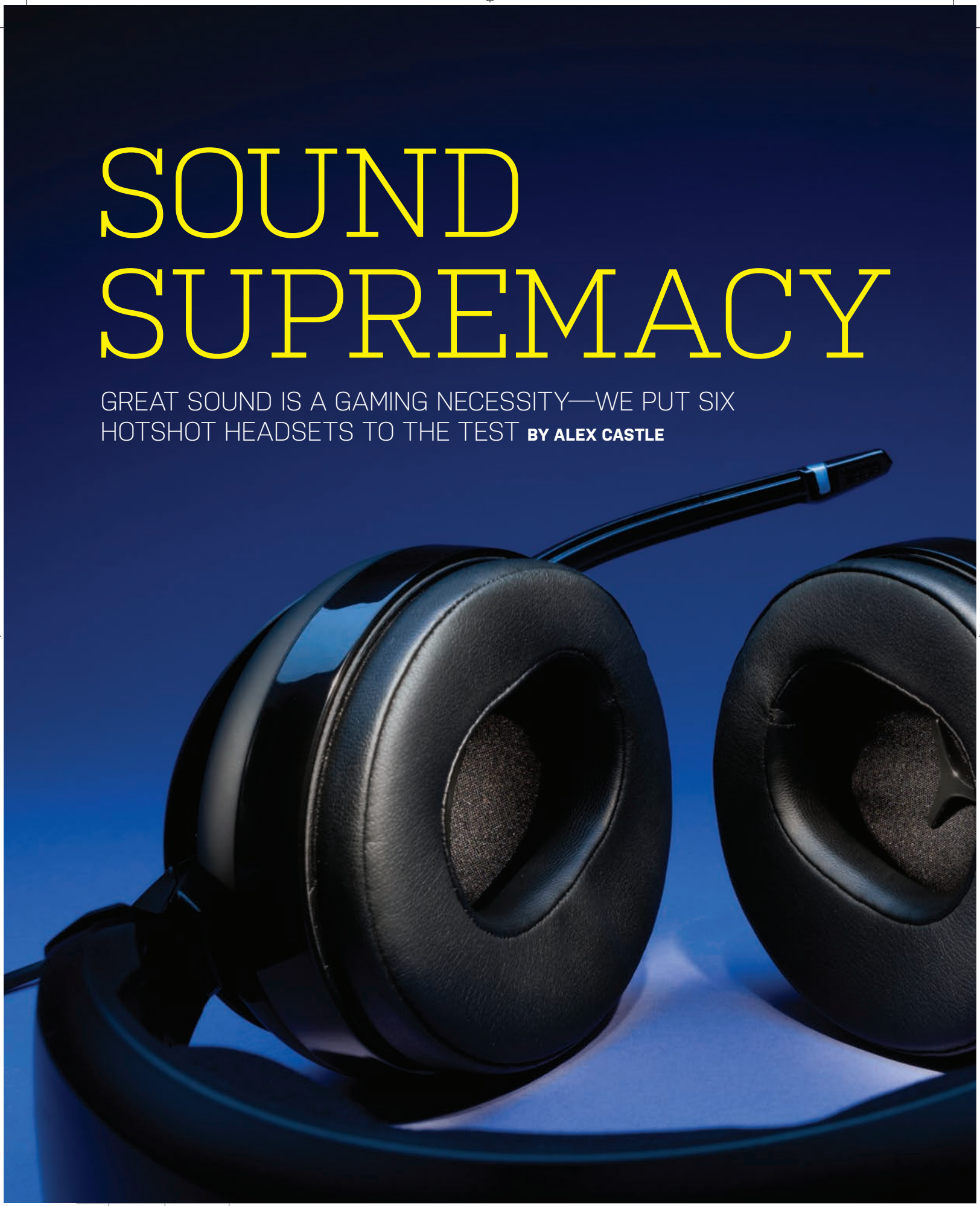
GREAT SOUND IS A GAMING NECESSITY—WE PUT SIX HOTSHOT HEADSETS TO THE TEST **BY ALEX CASTLE**



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For a gamer, top-notch sound is just as important as great graphics. Fancy, polygon-pushing GPUs may get all the attention in gaming, but if you pair them with a crappy pair of speakers or a low-rent headset, you're ruining the immersion and depriving yourself of a competitive advantage.

And if you do want excellent sound, a headset is the most practical way to go. Speakers are great, but they take up a lot of space, and unless you're gaming in your own fortress of solitude, those window-rattling bass thumps might not be appreciated by your neighbors or family. A high-quality headset gets you right inside the game, keeping the outside world out and the gaming world in.

We've rounded up six high-end units from respected peripheral makers, and put them through the paces. We evaluated each one based on the unique features it brings to the table, as well as the three criteria we value most: comfort, build quality, and audio performance.

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HELLO, 4K LCD!
Asus 31.5-inch panel boasts four times the resolution of 1080p PG. 76
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Seven 802.11ac Wi-Fi routers demo the new spec's capabilities PG. 34
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ROCCAT KAVE XTD

This big headset delivers true 5.1 surround sound

The Kave XTD's earcups feature a small opening that widens on the inside, sealing you off from the outside world.

GERMAN GAMING-GEAR company Roccat has been on the scene for a few years now, but is still making products like it's got something to prove. Roccat's newest headset, the Kave XTD, is a remarkably solid entry into the fast-growing "true 5.1" market.

Unlike "virtual 7.1" headsets, a true 5.1 unit such as the Kave XTD actually has multiple drivers in each ear, so that sounds that come from behind you in the game actually hit your ear from behind in real life. The result is excellent positional audio—easily the best of any of the headsets we tested for this article. For games as well as movies, the bass-heavy mix and convincing surround sound really enhance immersion. For music, the Kave XTD is acceptable but doesn't stand out from the crowd.

The Kave XTD includes a nicely designed desktop mixer with a built-in "soundcard." The mixer allows you to adjust your equalization on the fly and, interestingly, can connect to your smartphone with Bluetooth. When you get a call, you just punch a button on the mixer, and you can take it on the headset. Our only gripe with the mixer is that the Kave XTD is permanently connected to it—there's no way to use the headset by itself, or even to take them apart to store them.

Like many other true 5.1 headsets, the Kave XTD has a bit of a weight problem. It has a super-cushy padded headband to distribute the force from those maximum-diameter earcups, but it still started to feel a little oppressive during longer play sessions. We'd certainly prefer a slimmer design, but at this point in time, a little extra weight and size is just part of the trade-off for "true 5.1."

The other part of the trade-off is price. You get a lot of headset for your money, but the $170 price tag makes the Kave XTD more expensive than a lot of great-sounding cans. Still, if you want a well-built pair, and prioritize surround-sound gaming and movies above music, the Kave XTD is a strong choice.

VERDICT **8**

Roccat Kave XTD

$170, www.roccat.org

WE'VE GOT YOU SURROUNDED!

For a long time, surround sound and headsets were mutually exclusive. Headset manufacturers acknowledged the harsh reality that headphones, aka a pair of small speakers strapped to your dome, are by their nature a stereo experience. Even as 5.1 and 7.1 surround speaker setups started taking off in the home theater, and then with gaming PCs, nobody thought to market headsets as anything but stereo. All that has changed in the last couple of years, and now it's hard to find a high-end headset that doesn't claim to offer some sort of surround sound. Here's a quick primer on the surround configurations you're likely to encounter, and when they're the right fit.

7.1 Surround The hottest new trend in high-end headphones is being marketed as "Virtual 7.1" or even just "7.1 surround" headsets. Of course, these headphones still have exactly two drivers. The "7.1" label comes from the inclusion of built-in audio processing (these are always going to be USB headset or include a USB dongle or mixer) that takes a 5.1 or 7.1 surround signal from a game or movie, then mixes it down to two channels for the headset using techniques that create the illusion of three-dimensional sound. Of course, your game will do that by itself if you set it to output stereo audio, but the processing in a good pair of headphones will be better tuned to create positionality in a headset. The difference is noticeable, but not dramatic.

5.1 Surround 5.1 surround headsets, on the other hand, actually physically include multiple physical drivers in each earcup for better sound positionality. This can make a big difference, particularly with picking out whether sounds are coming from in front of or behind you. The trade-off with true 5.1 headsets is that they tend to be expensive, large, and heavy. Further, the multiple smaller speakers usually don't have quite the same dynamic range as the single large driver found in each earcup of stereo cans, making these inferior for listening to music.

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PLANTRONICS RIG

A gaming headset for the smartphone generation

The RIG can be detached from the desktop mixer for use on the go.

THE RIG'S MAIN selling point is that it's a headset that does double duty—you plug your gaming hardware and your cell phone into a single mixer, then toggle between the two simply by flipping a switch. Unlike the Bluetooth connection found in the Kave XTD, the RIG connects to the phone with an audio cable. It's less convenient, but the physical connection makes switching back and forth feel a little more responsive.

The mixer also includes a nice set of hardware switches for controlling both gaming and phone volume and other settings. The RIG can also be used as a straight-up phone headset, as it comes with an extra wire with an inline microphone, if you want to ditch the mixer and the boom mic entirely. It's a nicely designed product all around, with a simple look that favors clean, circular elements. The earcups and headband are plainer-looking than a lot of the competition, but they're comfortable and feel reasonably solid. The circular control pod is similarly attractive and feels nice and heavy on the desk. Its various buttons, toggle and sliders all feel durable and high-quality.

The RIG mixer is an interesting hybrid in that it uses your onboard analog ports but separates the microphone into a USB input. The mixer has three preset equalizer levels, but the stereo sound quality on the whole is neither outstanding nor unacceptable. You can find headsets with better sound quality for $100, but we have to assume anyone buying the RIG is at least partially invested in its unique, phone-based feature set.

VERDICT **7**

Plantronics RIG

$100, www.plantronics.com

CM STORM PULSE-R

This aluminum-clad headset fails to make an impression

The aluminum side plates on the Pulse-R are removable, but what you replace them with is anyone's guess.

AS A HEADSET, the Pulse-R is pretty plain, aside from some nice-looking LED backlighting (which is not customizable, and necessitates an otherwise useless USB connection), and some removable aluminum cladding on the earcups. We're all in favor of metal on our gaming hardware, but the aluminum here looks super cheap, particularly compared to the exposed steel in the headband. CMStorm advertises these aluminum plates as customizable, and they do indeed feature prominent hex screws if you'd like to swap them out, but we're not totally sure what you're meant to swap them out for.

The headset's construction feels solid, but we weren't crazy about the earcup design. The squarish cans are an in-between size—smaller than full circumaural cups, but a little larger than most on-ear earcups. We frequently found one or both ears getting bent out of shape while wearing the set. The leather earcups are nicely padded, but in all, we weren't impressed with the set's comfort.

The Pulse-R also features a poorly executed inline control unit. It's surprisingly large, with a cheap-feeling mute switch and volume slider. Despite the control's huge size, the volume slider only has about 5mm of travel, making it pretty worthless for fine volume control.

Sound quality was toward the low end of this roundup, with bass that was powerful but not terribly clear. For music and movies, the sound quality was especially bad, producing muddled audio that sometimes made it hard to hear dialogue and higher parts.

The CM Storm doesn't fall terribly short in any one area, but consistent quality issues and questionable design choices leave us unable to recommend this as a smart purchase.

VERDICT **6**

CM Storm Pulse-R

$90, www.cmstorm.co

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TRITTON KUNAI

A light-weight headset for gamers on a budget

The Kunai is marketed as a gaming console headset, but it doesn't have any console-specific features, other than audio-cable adapters.

SELLING FOR AROUND $50, the Tritton Kunai sits right at the entry level for real, high-grade gaming gear. For products in this category, the question is always whether they're actually a good option for budget-minded gamers, or if they're just pretenders that managed to sneak out of the bargain bin. So, where does the Kunai land?

First, let's talk build quality. As you would expect with a cheaper headset, the Kunai cuts some corners on construction. In all, it's all-plastic build feels perfectly fine, but two issues concern us: First, the headband is plastic throughout—there's no steel core to the band. Second, the audio cable that's attached to the headset is neither braided nor terribly thick. Both of these represent pretty easy ways the Kunai could wear out or break.

The headset is very light, and surprisingly comfortable with its pair of well-padded, rectangular on-ear cups. Its flexible boom mic is removable, and the earcups swivel to more easily rest on your collarbones while not in use. Between the small, lightweight design, removable mic, and smartphone-ready audio cable, there's a pretty compelling secondary use case for the Kunai as a portable headset that's also good for playing games at home.

For this price range, sound quality on the Kunai is good. It can't get anywhere near the clarity and power that some of the other headsets in this roundup offer, but that's what the extra $100 or so buys you. For at-home gaming use alone, you can find alternatives with better sound and features in this price range, as well. However, if you value light weight, portability, and value, the Kunai's not a bad deal.

VERDICT **7**

Tritton Kunai

$50, www.trittonaudio.com

STEELSERIES 9H

A durable headset with excellent fundamentals

When retracted, the microphone on the 9H is flush with the earcup's surface.

THE STEELSERIES 9H is, first and foremost, a well-built set of cans. The headband is built of steel, clad in an extra-rugged plastic. The earcups feature the same durable plastic as well as thick leather pads that are much suppler and less cheap-feeling than the leather found on even the most high-end models. Despite its solid workmanship, the headset is quite light for its size, and comfortable even after long sessions.

Sound quality is similarly respectable, with bass that can be pumped up to head-shaking levels without drowning out the respectably crisp mids and highs. By default, it seems tuned for gaming, but with the software equalizer you can get solid music and movie performance out of it, as well.

The 9H is flexible, usable either as an analog headset, or with an included USB dongle that offers the standard suite of audio processing, including the ubiquitous Dolby Headphone virtual 7.1. It comes with adapters for separate audio and mic connections or a single three-pole jack for use with phones and tablets. The braided cable includes a compact in-line remote with volume control and mic switch, as well as an optional extension that brings the total cable length to over 9 feet. When you're not using the flexible noise-cancelling mic, it retracts fully into one of the earcups.

At $160, the 9H is very expensive for a wired stereo headset, but you get your money's worth in comfort and audio quality. Some PC-exclusive gamers might find the similar-but-wireless Corsair Vengeance 2100 a better deal at around the same price, but for those specifically looking for a wired or analog version, the 9H is an excellent choice.

VERDICT **9**

Steelseries 9H

$160, www.steelseries.com

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CORSAIR VENGEANCE 2100

This wireless headset gives you your money's worth

SINCE ITS first entry into the headset market about four years ago, we've been reliably impressed with Corsair's gaming headphones. Corsair has consistently focused on build, comfort and audio quality, without tacking on needless features that send the price sky-high. The Vengeance 2100—the company's new top-of-the-line set, is no exception.

Like previous Vengeance headsets, the 2100 errs on the side of "too big." It's heavy because of the built-in battery, but it's not uncomfortable. We'd prefer a lighter headset, but Corsair's designed the Vengeance 2100 to handle its bulk the right way—by spreading out the weight evenly with a broad, padded headband, and huge, cushy earcups.

The Vengeance 2100 is a wireless "7.1 surround" headset. A lot of high-end headsets are calling themselves "7.1" these days, but that just means that they're stereo with built-in audio hardware for simulated 7.1 surround sound. As with most such headphones, the 7.1 surround in the Vengeance 2100 is an improvement over unprocessed sound, but it doesn't offer quite the same positionality as "true 5.1" surround like that found in the Roccat Kave XTD.

The actual sound quality of the Vengeance 2100 is top-notch. The punchy base and defined mids are great for picking out noises on the virtual battlefield and in movies. Unlike many of the other gaming-tuned headsets, the Vengeance 2100 sounds great playing music, as well. The bass response is still excellent, without the indistinct highs that can make music sound muddy. A true audiophile probably won't be in the market for a gaming headset in the first place, but it would be difficult to find headphones that sound better than this in the price range.

Of course, one of the main selling points of the Vengeance 2100 is that it's wireless. We found that the wireless worked perfectly, with no degradation of sound quality, good reception area, and an easy charging process. At $130, the Vengeance 2100 isn't cheap, but it's less expensive than most other high-quality wireless alternatives. With excellent sound quality, good comfort, and no major flaws, the Vengeance 2100 is a great deal and one we'd easily recommend.

VERDICT 9 KICK ASS!

Corsair Vengeance 2100

$130, www.corsair.comm

The Vengeance 2100's extra-wide headband helps distribute its substantial weight.

AUDIOPHILE HEADPHONES FOR GAMING?

Obviously, gaming headsets aren't the only game in town when it comes to head-mounted audio. There are plenty of cheapo earbuds and on-ear headphones available for those who don't care much about sound quality, but there's also a whole world of audiophile hardware out there—high-quality headphones designed for maximum-fidelity audio. Most audiophile-grade equipment is seriously expensive, but some of the "entry-level" models fall in the $100–200 range, along with most of the headsets in this roundup. With sets like the Sennheiser HD558 highly regarded and available for $130, are there reasons to buy a gaming headset at all? Here are the pros and cons of using an audiophile version for gaming.

Pros An audiophile headset will almost always give you better fidelity for playing music, so if that's a major priority for you, you'd do well to consider going that route. Also, it's been our experience that build quality tends to be a little better. Finally, audiophile headphones are a lot more understated, design-wise. Whether that's a plus or a minus depends on your particular tastes, but we think there's something to be said for subtlety.

Cons To be able to use voice, you'll have to buy a clip-on microphone. You can get one for next to nothing, but we'd recommend springing for one of the $20–30 models if you want good recording capabilities. Audiophile headsets don't prioritize big booming bass the way gaming varieties do, so if you like brain-rattling explosions in your games, or even if you're a fan of bass-heavy music genres like hip-hop or EDM, you might not see much of an audio quality boost from cheaper audiophile cans. Lastly, many gaming headsets offer built-in audio processing, which can be a great value if you don't have a dedicated sound card in your rig.

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TABLETS

X86 TABLETS ARRIVE, BUT CAN THEY DEFEAT THE HORDES OF OTHER DEVICES?

BY TOM MCNAMARA

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ON TRIAL

Is a new wave of mobile x86 chips enough to help Windows fight off Android and iOS?

In October 2012, Windows 8 arrived in two very different flavors. One was the standard x86 version for desktops and laptops. But the other was for Windows RT, a hybrid laptop/tablet device powered by an ARM chip that couldn't run any x86 software. It wasn't until the following February that the Surface Pro came out, packed with a conventional Intel CPU. But by then, the damage had been done. It wasn't until late last year that x86 tablets started trickling out from Asus, Toshiba, and other usual suspects. Surface hybrids remained expensive, while Google's Android devices invaded price ranges well out of Microsoft's grasp.

Until now. Other big players such as Dell, Acer, and Lenovo have joined the Windows 8.1 tablet party, so we now have a critical mass of relatively inexpensive units with x86 chips under the hood. We've decided to put them through their paces to crown a champion... or dissect a disaster.

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ATTACK OF THE X86 TABLETS

CAN THESE TABLETS SURVIVE WINDOWS 8?

Over the course of the last twenty years or so, the various versions of Windows have taken on a release pattern similar to *Star Trek* films. The first one blew, while the second was great. Windows XP fab, Windows Vista not. Right now, we're dealing with the *Star Trek: V* of OSes with Windows 8.

Without getting into gory details, we can say that Windows 8 and 8.1 (referred to collectively as "Windows 8" from here on) have not seen the success of Windows 7. Microsoft announced in February that it had sold 200 million licenses for the newer OS, so it's by no means a failure. But that can get skewed by the number of laptops, desktops, and tablets for which Windows 8 is the only option—followed by wiping it and replacing it with Windows 7.

Microsoft's quoted number also doesn't take into account how many devices were returned shortly after purchase. This is a sticking point, since Windows 8 has gotten a Vista-level drubbing in the enthusiast crowd. Its tile-based "Modern" (aka Metro) interface is not particularly optimized for mice and keyboards; it defaults to full-screen apps for opening images, PDFs, and videos; the popular Start menu has been abolished (it may return with Update 1 by the time you read this, but we're not optimistic); and certain games and programs have compatibility issues.

Despite all that, there is still an appeal to exploring this new crop of Windows tablets. Since they use an x86 Intel CPU, they can run Microsoft Office, Photoshop, Steam, and pretty much any other piece of standard Windows software. In fact, all four of these tablets come with a copy of MS Office Home & Student 2013, which contains Word, Excel, PowerPoint, and OneNote. Not a trial version—a full-fledged copy with a product key. A Windows license would usually cost you about $100 for the OEM version, and Office 2013 goes for about $140. Since these tablets start around $250, this software is practically being given away.

On the hardware side, they all have IPS screens, which are much better than standard TN panels; in-plane switching tech has much higher contrast, so you get more vibrant colors and deeper blacks. The screens are all eight inches diagonally and display 1280x800 pixels (except for the more expensive ThinkPad 8, which is 8.3 inches and has 1920x1200 pixels). 2GB of system RAM is the standard, and that doesn't sound like a lot, but Windows 8 can be surprisingly efficient with its memory. Two units have 32GB of internal storage, while the other two have 64GB. All have SD card slots that can accept up to 64GB.

The bottom line is that these are not Windows RT devices in a smaller form factor—these are full-on Windows PCs shrunk into tablet form. The secret sauce is Intel's new line of Atom CPUs. These dual-core and quad-core x86 units are what make the whole shebang possible, by running regular Windows programs with acceptable speed, but without eating your battery. They're nothing like the old Atom chips, thank goodness. They'll even do some heavy lifting in a pinch, like HD video encoding. Unfortunately, these tablets all run 32-bit Windows despite the chips being 64-bit, so a few 64-bit only applications may not work. But Intel's gear is fundamentally sound.

Questions still plague the software side, though. How viable is Windows 8 as a touch-aware operating system? How many precious gigabytes does it take up on a mobile device? Is this stack of tablets the first salvo of an oncoming legion, or just a trial run? We think we can answer the first two. The answer to the third one ultimately depends on the end user. In other words, you, the reader. Are you ready to go where no one has gone before?

THE STORY OF A STORE

One of the key ingredients to Windows 8's success (or failure) is the Windows Store. In theory, this would behave like Android's Play Store or Apple's iTunes Store. You'd buy apps, movies, music, books, and magazines through it, and all that content would be linked to a single account for later retrieval on multiple Windows 8 devices owned by the same individual or family.

But there are a few drawbacks. The store is only accessible through Windows 8, and you won't see a link to it in Windows unless you're viewing the Modern UI screen. If you're a mouse and keyboard user, you've probably already tweaked Windows to boot straight to "desktop" mode instead. So, in practice, the store has not quite achieved the same level of visibility or success as Apple's or Google's stores.

For example, Mozilla recently pulled the Modern UI beta of its Firefox Internet browser because, according to company VP Johnathan Nightingale, "We've never seen more than 1,000 active daily users in the Metro environment." Given that Microsoft has sold more than 200 million Windows 8 licenses, a thousand users is within the margin of error—a number so small that it could be the result of an accidental mouse click. Since the touch-optimized Modern interface is designed to be a tablet PC's information hub, the lack of interest in the Modern UI flavor of a popular program like Firefox indicates that the Windows Store and Modern itself are not strong contenders for Interface of the Year awards. Thankfully, desktop mode is still a click (or tap) away, and you can set Windows 8.1 to boot to it automatically.

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WINDOWS TABLETS VS. THE WORLD

HOW DO THESE X86 TABLETS STACK UP AGAINST THE LEADING CONTENDERS?

The primary competition to these mini Windows tablets isn't really Windows laptops—it's the new tech gadgets. So, to find out how these tabs stack up, we weighed their pluses and minuses against three competing platforms. **–GU**

VS. CHROMEBOOK

Google Chromebooks have been a surprise hit among students and people looking for low-maintenance and low-cost computing. Unfortunately, Chromebooks are also low in functionality, especially compared to the tablets in our roundup. These tabs give you full x86 compatibility, which means that they'll run your regular desktop apps. Sure, they'll be slower or cramped on the small screens, but at least you can VPN to work on the obscure proprietary VPN software that the company runs. Light-duty Photoshop and 100 percent fidelity with Office documents is also within reach on these tablets. We'd even have to admit that Modern apps are actually richer in functionality than Chrome OS apps. Where the Chromebook rules is in cost—the cheapest tablet here is $250 without a keyboard. A great Chromebook can be had for $200 with a comfy keyboard included. Chromebooks also offer more resistance to malware. And if you lose one, your data isn't lost, as it's all in the cloud. Which is best? It very much depends on your needs. We actually see the appeal of the Chromebook for certain high-risk use cases or for someone who needs its zero-to-no-maintenance. At the same time, the ability to have a real OS and x86 processing in a tablet is also rather appealing for those times when you need (or want) a real Windows machine.

VS. NEXUS 7

We love the Nexus 7 tablet. It's fast, small, light, and packs a high-res screen with none of the scaling issues that Windows has on high-DPI panels. It may not have the power or capability of a mini Win tab in x86 apps, but the Google Play Store makes up for it in a lot of ways. It also helps that Android is a real fat-finger OS. Meanwhile, Modern is a work in progress, and desktop apps are a keyboard/mouse affair. Office productivity is also quite good, thanks to many Office-like apps, but it's still not a real copy of MS Office. If we had to break it down, we'd take the Nexus 7 on a strictly no-work vacation for watching videos, using as an eReader, and playing Angry Ferret on the flight. If that trip required work or access to local files through the VPN, having the capability of full x86 Windows functionality is quite comforting, and we'd swap it out for a Windows tablet. The most disappointing aspect of Windows tablets, though, is the truly pathetic app store and lack of native Modern support for Google's ecosystem. But hey, the "legacy" apps work. We could honestly see keeping both in our tech garage and pulling out the right tool for the job. If you're wondering why we didn't include a mini iPad here, iOS fans can just cut and paste Nexus 7 with the iPad Mini and you'd get the same result.

VS. SURFACE RT

Yes, the original Windows RT is technically a competitor. The original Surface RT is now $300, which puts it in striking range of the Windows tabs. Unfortunately, that just means the mini Windows tablets get to strike Surface RT in the face repeatedly. While we laud Microsoft for some of the design features of the Surface RT and Surface 2, lower-cost Windows tablets really put the hurt on Windows RT. Although you get a free copy of Office 2013, the inability to run x86 apps really makes us wonder if Microsoft should continue with Windows RT at all now. All it offers you is the ability to access the Modern store, which is as bare as a grocery store six months after the zombie apocalypse. And yes, it's really that bad. With sub-$300 Windows 8.1 tablets, there's just no reason for Surface RT and Surface 2 to exist anymore. We'd prefer a Surface RT-like device running with an Intel Bay Trail Atom chip and Windows 8.1, for $300 or less. Throw in the copy of Office 2013, and you'd have an instant winner, in our book. But just in case you didn't hear us—we see no reason to run a Surface RT or Surface 2 in the face of the mini Windows 8 tablets today.

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LENOVO THINKPAD 8

LENOVO CREATES SOME SURFACE TENSION

MOST 8-INCH WINDOWS tablets are aiming for the $200–300 price range, so Lenovo might seem a little out of touch when it crowds in with a $500 unit. The ThinkPad 8 is the nicest looking of the lot, at least. It's the only one with a metal back, which helps with durability and also heat dissipation. The trim is rubberized to assist your grip, and the buttons look and feel sturdy. In your hand, it feels like a unit built for the long haul. Also, the rear camera has a flash LED, a rare and welcome addition on a tablet.

The 1920x1200 screen also has more than twice as many pixels as the 1280x800 screens on the three other tablets in this round-up. So, all of Windows 8.1's text and icons render more sharply on the ThinkPad 8, and you can watch videos in full HD. Granted, these are all IPS displays, so color accuracy, viewing angle, and contrast are very good regardless. But the ThinkPad 8's graphical clarity is unmatched.

It's a double-edged sword, though. At 1200p, icons and other touch-enabled items are that much smaller, so the ThinkPad 8 is more reliant on a keyboard and mouse than the other three. This is not exactly the tablet's fault, though; Windows 8.1 itself is only partly navigable with touch, and publishers have not flooded the Windows Store with Modern versions of their software. If you want mobility with fluid touch-enabled functionality, you have better odds with Android and iOS.

The other major difference is the ThinkPad 8's quad-core Intel Atom Z3770, which runs at up to 2.4GHz, while the others in the roundup top off at about 1.8GHz. It took about ninety minutes to finish our ProShow benchmark, while the others took two hours or more. A desktop Core i5 with Haswell guts will knock that out in about 30 minutes, so the Z3770 isn't a barnstormer. But for a tablet and Atom, it's not bad. The tablet's 2GB of system RAM is also a limitation—don't expect to have a lot of browser tabs open while encoding HD video. On the other hand, the ThinkPad's CPU is using a fraction of the power of a desktop chip, so it's a great accomplishment on a performance-per-watt basis. Keep in mind, though, that it certainly won't replace your gaming machine anytime soon. It can handle pixel-art side-scrollers like Terraria and Fez, but even a relatively modest older shooter like Prey needs greatly reduced resolution and visual settings.

Like the other Windows tablets we're reviewing today, the ThinkPad 8 also cannot use a USB cable to exchange data with a laptop or desktop PC. If you want to transfer files to your tablet, you have to connect over Wi-Fi or Bluetooth, which is slow and subject to interference, or copy the data to a USB flash drive and connect that drive to the tablet with an OTG cable, which is tedious and also slow, since you're limited to USB 2.0 speeds.

The ThinkPad 8 lives up to the name with a durable metal back.

Unfortunately, that $500 price tag is a tough sell, since you're entering the territory of Microsoft's original Surface Pro tablet–with an Intel Core i5 CPU, 4GB of RAM, a 10.6-inch screen, and the 64-bit version of Windows 8.1 (though battery life is not great). This flavor of the ThinkPad 8 also gets the trial version of Office, since Lenovo does not bundle that with tablets that come with Window 8.1 Pro. (Microsoft's licensing can be quirky sometimes.) The ThinkPad 8 with regular Windows 8.1 costs $100 less and comes with Office Home & Student, like the others in this roundup. It's a much better deal for those who don't need say, BitLocker or the ability to join a domain.

BENCHMARKS

	Lenovo ThinkPad 8	Asus T100 (zero point)	Difference
3DMark Ice Storm	14,017	15,264	-8.2%
ProShow (min)	96	164	46.4%
Google Octane	6,661	3,896	41.5%
Battery (min)	252	347	-27.4%

VERDICT **8**

Lenovo ThinkPad 8

$500, www.lenovo.com

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DELL VENUE 8 PRO

32GB IS DIFFERENT IN THE WINDOWS WORLD

THE LONGER the name of a product gets, the more you wonder about the potential variations. The Dell Venue 8 Pro (DV8P) takes a particularly interesting tack. This "Pro" is not an enhanced edition of the Venue 8. The Venue 8 is, in fact, a completely different product: It runs Android 4.2.2. instead of Windows 8.1, and it has a slower ARM CPU and RAM.

Confusing nomenclature aside, the DV8P is a decent Windows 8.1 tablet, for the money. Its display is vibrant (though all the screens in this roundup are glossy, so your mileage may vary). The buttons and slots along the sides are all sensibly located; none of them will be blocked by a decent case, either when closed or when folded to act as a stand. The back is rubberized and textured, so you don't need a case to keep it from slipping out of your hand. The bezel around the screen is thicker than average, but there are no logos on it; the only break in its surface is a little pinhole for the front-facing camera. The Windows button is even located on the edge of the tablet, while the others tablets in this roundup display it somewhere on their bezel. Minimalists should be pleased. The speaker on the side is mono but surprisingly loud. (The other tablets have "stereo" sound, but their speakers are adjacent, negating the separating effect.)

Under the hood, the DV8P uses a quad-core Intel Atom Z3740D chip. The "D" is for Atoms that lack dual-channel RAM support. On paper, this reduces its memory bandwidth by up to 6.5GB/s, compared to the regular Z3740 in the Acer and Toshiba tablets. But in practice, we didn't see a noticeable weakness. In fact, the Acer tablet took about 15 minutes longer in our HD video encoding test, a benchmark where memory bandwidth usually makes a difference. The Toshiba tablet encoded about as fast as the DV8P. (We did all tests with the units plugged into an AC outlet, to counter the effect of energy-saving power-throttling presets.)

Unfortunately, storage space is a problem. The "32GB" version reviewed has only about 10GB of space, once Windows 8.1 and Office 2013 are on the device. You can pull some judo with things like recovery partitions and hibernation files—but it'll never be close to what Android or iOS can do with that much space, since those operating systems and their downloadable apps are designed to fit on devices that have limited storage. Being able to run programs like MS Office and Photoshop is a nice perk, but it's not going to store much media. The SD card slot can add another 64GB, but most SD cards run much more slowly than internal memory, and some programs partly install on the C drive no matter what you tell them. For Windows tablets, 64GB of internal memory is the way to go.

The Venue 8 Pro's budget appeal has made it quite popular.

The DV8P also lacks HDMI output. You may not care about that, but the very similar Acer Iconia W4 comes with it and is currently priced the same. You can use a third-party dock, but those can easily run into the triple digits, and ones like the Plugable UD-3900 require an OTG cable connection, which disables charging. Miracast is still available, but it requires another dongle if you're using a standard computer monitor, and you have to set up another Wi-Fi connection. Hooking up an HDMI cable is faster, cheaper, and easier. Being $250 does take out some of the sting, though.

BENCHMARKS

	Dell Venue 8 Pro	Asus T100 (zero point)	Difference
3DMark Ice Storm	15,763	15,264	3.1%
ProShow (min)	118	164	28.1%
Google Octane	5,604	3,896	30.5%
Battery (min)	295	347	-15%

VERDICT 7

Dell Venue 8 Pro

$250, www.dell.com

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TOSHIBA ENCORE WT8

IT WON'T GET A STANDING OVATION.

The 32GB version is difficult to find, compared to the more popular 64GB WT8.

ON THE SURFACE, the Toshiba Encore is a pretty standard Windows 8.1 tablet for its price range. It has the increasingly familiar quad-core Intel Atom Z3470 chip, 2GB of RAM, an SD card slot, MS Office Home & Student, HDMI output, and a 1280x800 IPS screen. So far, so good. It's probably closest to the Acer Iconia W4 reviewed on the previous page.

However, when you turn on the Encore, you'll notice that its desktop is completely free of extra stuff, unlike the W4. On the Encore, Windows looks like a freshly installed copy. If you go to Programs and Features, you'll see several Toshiba programs, but they don't clutter your desktop with icons or popup windows. The sole capitulation to bundleware is a pre-installed copy of Norton Internet Security. Now, don't run away screaming. Norton has actually improved by leaps and bounds in recent years, with better malware detection, user interface, and resource usage. And keep in mind that Toshiba is not including this stuff to annoy you, or even to hand-hold the newbies. Companies pay OEMs to be pre-installed on devices, lowering the costs. If you don't want it, you can just head over to Programs and Features and nuke it from orbit. It'll never bother you again.

It's true that we talk a lot about the backs of these devices, but with a mobile gadget that's intended to be held in one hand, it's important to have a good grip and logically placed buttons and inputs. And you'd be surprised by the number of people who don't put cases on their tablets (and phones, for that matter). Some people don't like the additional bulk and weight, and that's fine. To them, we say that the back of the Toshiba doesn't grip very well (but it's thankfully not as bad as the Iconia W4). It has squared-off dimples, but they're too flat and smooth to have a material impact on your ability to hold the device. Thankfully, Amazon and other stores currently have stacks of cases that you can try out. The back is the most obviously plastic one in this roundup. Though Toshiba gets points for being the only tablet with its microphone placed far enough away from the volume buttons that clicking them won't interrupt a recording. In fact, it has *dual* mics for additional noise reduction. The micro-USB and Micro HDMI connectors are right next to each other, though. Since they're shaped almost exactly the same, you have to tilt the tablet every time and inspect the situation, to avoid using the wrong plug.

Unfortunately, this Encore is the 32GB version. After installing a couple of benchmarks, we had 7.2GB of space remaining on the internal storage. Once the manufacturer has created the recovery partition, you have just 23.3GB of space on the C drive. At least 15GB of that will be taken up by a fresh copy of Windows. While Android and iOS are built to fit on mobile devices, Windows 8.1 is not a lean system, and it shows here. You can delete the recovery partition, disable hibernation, and Google other tweaks, and you'll probably end up with the same amount of space that Android will give you on a 16GB device. The necessity of 64GB on a Windows tablet means a price tag of $300 or more, while a Nexus 7 can be had for $230—albeit with only 16GB. You can't run MS Office or Photoshop on Android, though, so it's not a clear-cut scenario. But then the Windows tablet also needs a mouse, keyboard, USB flash drive, and an OTG cable.

BENCHMARKS

	Toshiba Encore WT8	Asus T100 (zero point)	Difference
3DMark Ice Storm	15,709	15,264	2.8%
ProShow (minutes)	119	164	27.4%
Google Octane	5,539	3,896	29.6%
Battery	302	347	-13%

VERDICT **7**

Toshiba Encore WT8

$300, www.toshiba.com

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ACER ICONIA W4

OVERCOMING PRESENTATION.

The lowered section on the bezel actually help with orientation sometimes.

ACER IS BETTER known for its monitor and laptops, but the company's presence in the tablet game has been gaining steam. The Iconia W4 is not drastically different from the other guys in this roundup. It has a quad-core Intel Atom Z3470 CPU, 2GB of RAM, 64GB of internal storage space, Windows 8.1, Microsoft Office Home & Student 2013, a 1280x800 IPS screen, SD card slot, and HDMI output. So far, so good.

This is actually a big step up from the W3. That version had a pokey dual-core CPU, a TN screen instead of IPS, no light sensor to assist the camera or display brightness, a 2MP rear camera instead of 5MP, no camcorder mode, a maximum of 32GB of storage, and a relatively modest 3,400mAh battery, versus the W4's 4,960mAh. For Acer, the W4 is a triumph before you even take it out of the box.

Interestingly, the unit comes wrapped in a plastic sheet with a printed diagram on it. This diagram indicates where all the buttons and inputs are, and what they do. It seems like a small thing, but this could be a big deal for someone who's never used a tablet before. Once you've taken the sheet off, though, you'll notice that the back of the device is very slippery. If you don't buy a case for this guy, you're rolling the dice. Just handing the tablet to someone might make your heart skip a beat. The inlaid logo looks good, and the faux brushed aluminum surface is about as nice as you can expect plastic to be. But the W4 pretty much requires at least one accessory to be on even footing with the other Windows tablets in this roundup. Thankfully, there are plenty of solidly rated cases on Amazon available, at least at the time of this review.

When you start up the device, you may notice an unusual number of unfamiliar icons on the desktop and even in the taskbar. Enthusiasts call this "cruft." Acer has pre-installed software for its own branded VPN (virtual private networking), cloud storage, an "Acer Portal" that consolidates a remote access service with the usual links to support and warranty web pages; "Acer Photo," which is a sub-category of their cloud service; and more desktop shortcuts for eBay, Acer's online store, and Norton Online Backup. The taskbar integrates an Amazon product search engine that's actually pretty nice.

The "Acer Portal" is particularly distracting because it periodically pops up until you've created an "Acer ID" to access all the services promoted on the desktop. But you can uninstall the cruft in Windows' "Programs and Features" control panel pretty quickly, so it's more of an initial irritation than a persistent issue.

With 64GB of internal memory, the W4 also delivers on the minimum storage space that Windows seems to need. After formatting and the installation of Windows, there's about 25GB left over.

The ProShow benchmark took an additional 15 minutes to finish, versus the very similar Dell and Acer hardware, indicating the unit was likely throttling for thermals (all tests were conducted with AC power, so we know it wasn't an energy-saving preset in Windows.) But it's difficult to pin down the source of the issue, since it's early days for x86 Windows tablets. This shortfall did not carry over to the other benchmarks, which measure gaming and web browsing speed—things that you're much more likely to do with a tablet. We like to push CPUs beyond their normal limits, just to see where they'll go. And a Z3470 performs quite well for the money and for its intended role.

BENCHMARKS

	Acer Iconia W4	Asus T100 (zero-point)	Difference
3DMark Ice Storm	15,098	**15,264**	3.1%
ProShow (minutes)	138	164	15.9%
Google Octane	**5,409**	3,896	28%
Battery	304	347	-12.4%

VERDICT **8**

Acer Iconia W4

$300, www.acer.com

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A TOUCHING FINALE

WE HOPE YOU LIKE ACCESSORIZING

As the first generation of mobile Windows 8 devices running on x86 chips, this selection of tablets is actually not bad. Had they all come with 64GB of internal storage instead of 32GB (we had two each of 64GB and 32GB), we would have seen a much stronger showing. A proper Windows PC simply needs more than what is left over from 32GB after installing the OS and an office suite. And right now, that means spending at least $300 for the 64GB flavor.

And since Windows 8 doesn't have a conventional mobile interface, you need a mouse and keyboard to make full use of it. The on-screen keyboard does text prediction and pops up when you tap a text entry area—but only when you're using a Modern UI app or Office 2013. In desktop mode outside of Office, you have to tap on a tiny button on the taskbar, and it can take a few tries until it comes up. So, expect to shell out another $50 or so on a keyboard with a trackpad. Then, you'll probably want a USB flash drive and an OTG cable (or you can get one of those flash drives that have both regular USB and micro-USB connectors). That USB flash drive/OTG cable combo would be about $25, given a 32GB drive.

That comes out to about $375, versus a $250 street price for a 32GB Nexus 7 (and a Nexus 8.9 is apparently on its way soon, which would drive the price down further). The N7 has a 1920x1200 screen, a touch-optimized OS that scales with high DPI, a quad-core CPU (albeit ARM), an optional HDMI dongle, wireless charging, and the ability to mount as external storage when you connect to your PC with a USB cable. That's some stiff competition, even though it doesn't run Office or have an SD card slot.

These Windows tablets' inability to mount as USB storage is more than an irritation. Once you've spent some time in the Android world, *and nothing happens* when you plug Windows 8 tablet into a PC, it's downright bewildering when you expect to be able to drag and drop large media files. It takes some Googling to figure out that nothing is actually wrong with the device—that's just how the Windows tablets are built. If you want to use these as a mobile extension of your desktop, invisibility is a bit of an obstacle.

Granted, streaming your media from an online service is pretty popular. Netflix is so cost-effective that you can't afford *not* to subscribe. But when you're actually mobile, especially on road trips, there's no substitute for physical storage. The ability to use that storage quickly and efficiently is well understood by most other device makers. Plug it in, copy the files, done.

The performance of these Windows tablets is generally fine, though. The Atom Z3740 has a much lower clock speed ceiling than the Z3770, and both are much slower than a desktop CPU, but they didn't lag much when starting up Windows, opening various programs, or watching HD video. Even when limited to 2GB of system RAM, Windows 8 still remains snappy, as long as you don't have a few dozen browser tabs open, with maybe a big Excel spreadsheet.

In that respect, it won't replace a laptop as a mobile office or gaming platform. And since Windows 8 is only partially touch-optimized, the tablets in this roundup are not well positioned to replace the popular Android and iOS competition, either. After working with four of these Windows tablets and comparing them to our experiences with Android and iOS, it feels like the Windows OS needs a fundamental overhaul to come in line with the mobile competition. A large part of that is scaling icons, buttons, and text-entry areas for fingers instead of mouse pointers. We've seen the start of this in the Modern interface, but the OS as a whole needs a unity of design geared for mobile input methods before these tablets can be freed of mice and keyboards.

Still, it's hard to deny that there are some good bargains in here, for what you're getting. About $300 before accessories gets you a mobile Windows 8.1 device with an HD IPS screen, a "real" x86 CPU with four cores, and a copy of MS Office. Hopefully, the next major version of Windows will just split off into two versions—one optimized for mobile and other optimized for desktops and laptops—instead of Microsoft trying to mash both uses into one product.

SPECIFICATIONS

	Lenovo ThinkPad 8	Dell Venue 8 Pro	Acer Iconia W4	Toshiba Encore WT8
CPU	Atom Z3770	Atom Z3740D	Atom Z3740	Atom Z3740
RAM	2GB LPDDR3/1333	2GB DDR3L-RS/1600	2GB LPDDR3/1066	2GB LPDDR3/1066
Internal Storage	64GB	32GB	64GB	32GB
Resolution	1920x1200	1280x800	1280x800	1280x800
Ports	Headphone/Mic, Micro USB 2.0, Micro HDMI	Headphone/Mic, Micro USB 2.0	Headphone/Mic, Micro USB 2.0, Micro HDMI	Headphone/Mic, Micro USB2.0, Micro HDMI
Cameras	8MP rear w/flash, 2MP front	5MP rear, 1.2MP front	5MP rear, 2MP front	8MP rear, 2MP front
Dimensions H x W x D (inches)	8.7 x 5.2 x 0.36	8.6 x 5.1 x 0.37	8.4 x 5.4 x 0.42	8.5 x 5.3 x 0.43
Weight (ounces)	14.3	13.7	14.3	15.3
Price	$500	$249	$299	$299

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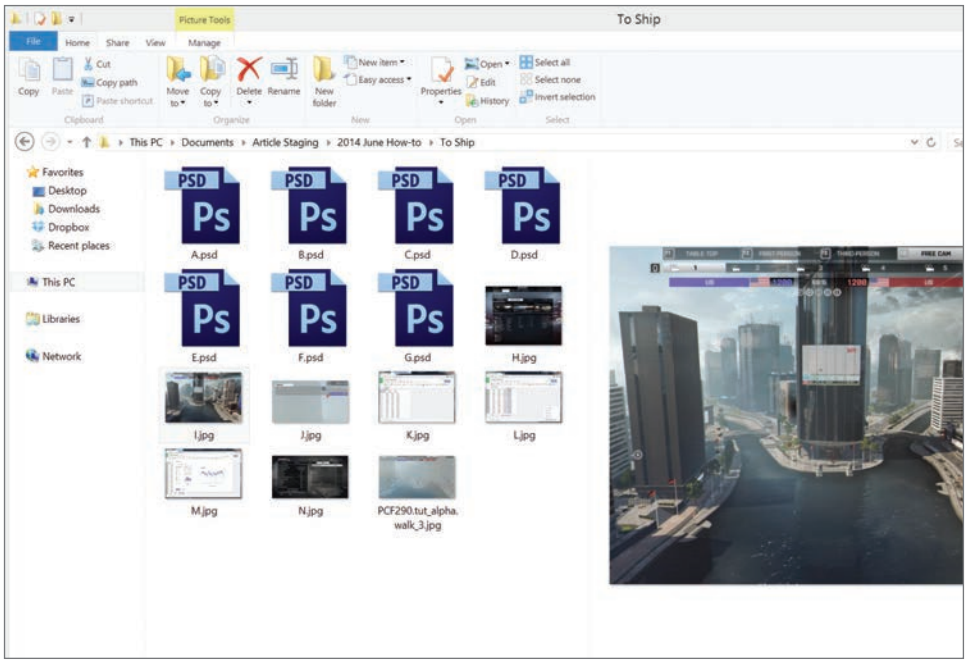
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

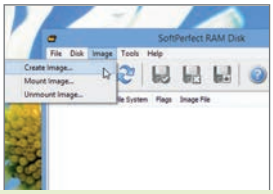
WINDOWS TIP OF THE MONTH

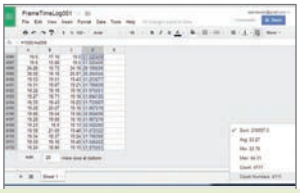


ENABLE OR DISABLE THE PREVIEW PANE

The preview pane in File Explorer is a huge help for browsing pictures and documents, but gets in the way when navigating other types of files. To quickly switch it on or off, just hit Alt + P while File Explorer is your active window.

MAKE - USE - CREATE





60 Create a RAM Drive

62 Benchmark Battlefield 4

ALEX CASTLE
CONTRIBUTING EDITOR

IMAGE FORMATS: THEY MATTER

I GRIT MY teeth every time I see compression artifacts in a website logo or on a printed-out flyer. Even if you rarely deal with graphic design software, you should understand the important distinction between JPEG and PNG files—using the wrong file format is a quick way to make any image look sloppy. Here are the rules.

For photographs, use JPEG. If you want to store regular digital photographs, JPEG is the right format to use, and will produce the most compact files.

For everything else, use PNG. JPEG files are the most compact because they use efficient, lossy compression. "Lossy compression" means that data is actually lost in the process, making your picture fuzzier and introducing a type of noise referred to as "JPEG artifacts." In busy images like photographs, the artifacts are barely noticeable. In illustrations, logos, or any images with large blocks of solid colors or text, the artifacts are *very* noticeable. If you're not sure, use PNG. Unlike the older GIF format, PNG can handle photos just fine, as well—the files will just be a little larger.

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Create a RAM Drive

YOU'LL NEED THIS

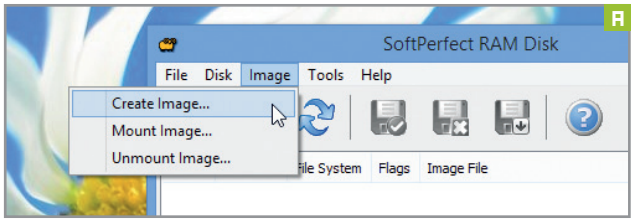
SOFTPERFECT RAM DISK
Get the free download from http://bit.ly/MPC_RamDisk.

THE CONCEPT OF TAKING unused memory and turning it into a lightning-fast virtual drive that also reduces the wear and tear on your hard disk is nothing new, but using RAM has traditionally had one major drawback: its volatile nature means all data is lost when power is cut, such as when you turn off or restart your PC. However, thanks to modern tools like SoftPerfect RAM Disk, that's no longer a problem.

SoftPerfect is a free tool that regularly saves the content of your RAM to an image file, so you can use it to store all kinds of data, not just temporary files. You'll have to put up with slower startup and shutdown as the image is either loaded into RAM or updated, but we'll show you how to strike a balance between performance and boot times. It works best with modern PCs with 4GB of RAM or more, but you can still take advantage with as little as 1GB—read on to find out how. **–NICK PEERS**

1 GET STARTED Install SoftPerfect RAM Disk from http://bit.ly/MPC_RamDisk. Leave "Launch SoftPerfect RAM Disk" checked on the exit screen and click Finish. When the main screen appears, select Image > Create image (**Image A**). First, you'll need to pick a location to store your RAM disk image—this will let you keep data whenever you shut down or restart your PC.

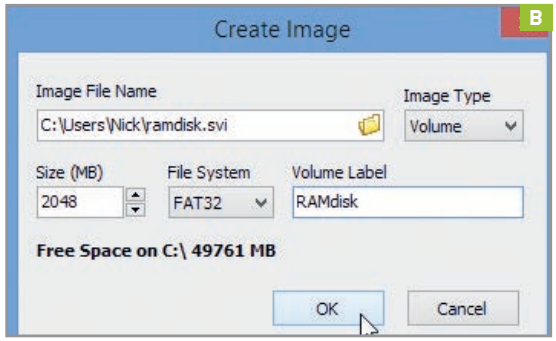
» Click the folder icon to choose where to store this image. Loading and saving this at startup and shutdown lengthens boot times, so with this in mind, save it to your fastest drive (preferably SSD). Give it a suitable name—say, RAMdisk—and click Save. Now, set its size, limiting it to either 2,048MB or a maximum of 25 per cent of your PC's total RAM, whichever is smaller.

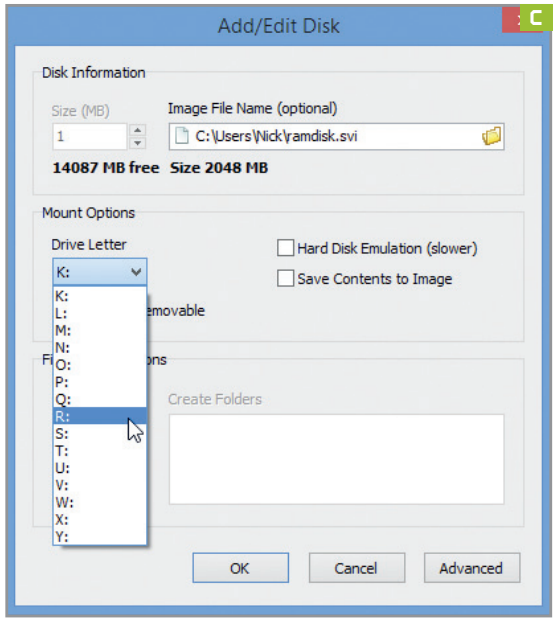


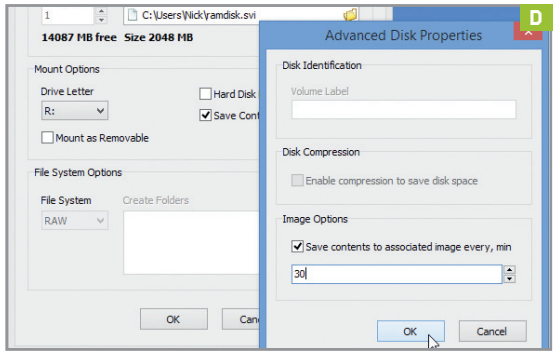
2 SET UP A RAM DISK Set the file system to FAT32 and type **RAM disk** or some other easily identifiable name into the Volume label box. Verify that Image Type is set to Volume, then click OK to create the image file. This can take some time, so be patient and ignore any Not Responding messages. Once the image file has been created, ignore the prompt to mount the image drive and click OK (**Image B**).

» Click the "+" button to create a new RAM disk. Start by clicking the folder icon to locate the file you created earlier. Next, pick a suitable drive letter that won't clash with anything else—"R" for RAM disk might be a good option (**Image C**). Tick "Save contents to image" to ensure that any data stored in your RAM disk is updated when your PC shuts down or restarts.

» If your PC crashes, you'll lose any changes that have been made to the RAM disk since your last reboot or startup. To back up changes to the disk image regularly, click the Advanced button, tick "Save contents to associated image every x min," and set it to a figure that's balanced between performance and protecting data on the RAM disk—30 would work well. Click OK (**Image D**). Click OK to mount the drive.







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3 PUT YOUR RAM DISK TO GOOD USE Once the drive has been created, you can start using it. First, open the drive in Windows/File Explorer and create two folders: TMP and TEMP. Now, switch back to SoftPerfect RAM Disk and choose "Tools > Set Windows TEMP folder." Type **R:\TEMP** and **R:\TMP** into their respective boxes, replacing "R" with the letter you assigned your RAM disk (**Image E**).

» You can now use the RAM drive like any other. Just create the relevant folders on the drive, then instruct any relevant applications to use them. You shouldn't store any personal folders such as your documents on the drive, just in case the PC crashes between backups. Here are a couple of good places to start, if you're looking to speed up your system.

» **Program Caches** If your favorite program makes use of temporary folders or caches, check its settings for an option to move these to your new RAM disk.

» **Portable Applications** Portable apps are self-contained, so they're perfect candidates for switching to your RAM drive if they're currently being stored on a slower hard drive.

» **Firefox Cache** Install the Configuration Mania add-on (http://bit.ly/MPC_ConMania) and select "Firefox > Options > Configuration Mania > Browser Cache" to change its location.

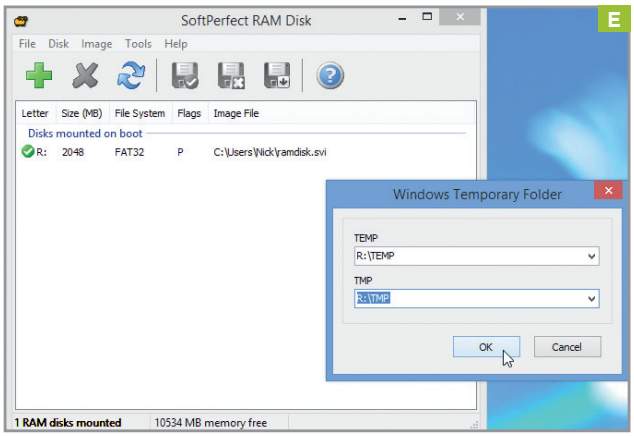
» **Internet Explorer Cache** Select "Tools > Internet options > Settings" under Browsing History. Click "Move folder" to select a folder on your RAM disk, then click OK twice before logging off when prompted.

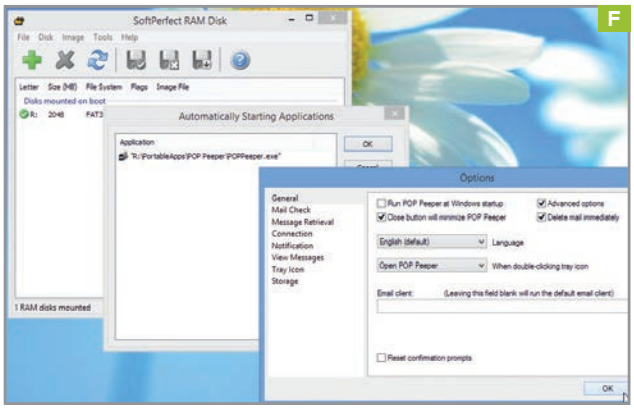
» **Google Chrome Cache** Moving the Chrome cache isn't for inexperienced users—you'll need to follow a relatively complicated procedure outlined under "A better way" at http://bit.ly/MPC_essayweb.

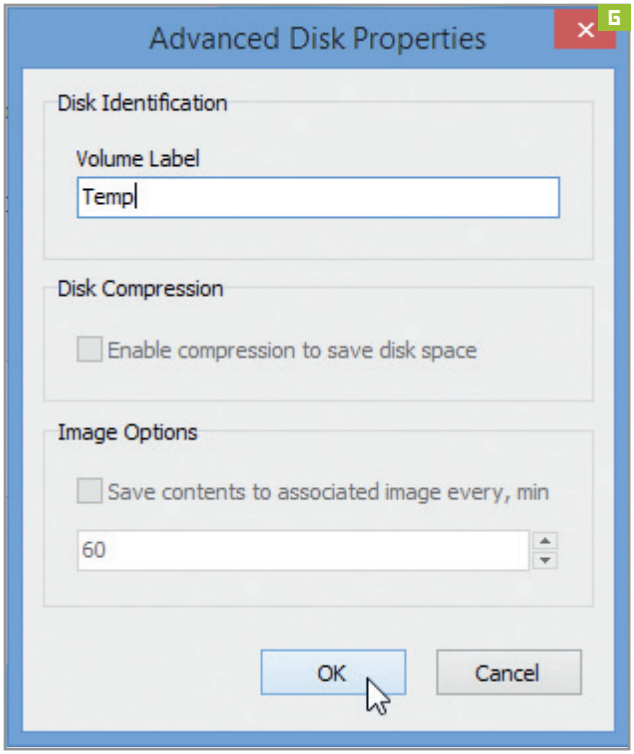
» If you move folders or caches related to programs that start with Windows, you'll need to disable their auto-start entries (look within the program for this setting). Now, open SoftPerfect RAM Disk Manager and choose Tools > Applications. Click Add to select the program file, then click Open > OK (**Image F**) so the program auto-starts again, but only after the RAM drive is ready.

» You can only make changes to your RAM disk by deleting and recreating it, thus losing all data currently on the disk. First, copy any files from it that you wish to keep, then set your Windows TEMP folders back to their default values via "Tools > Set Windows TEMP folders." Close any apps using the RAM disk, then right-click the RAM disk, and click Delete, forcing a dismount if required.

» Depending on which files you transfer to RAM disk, you should soon notice some performance gains. Your hard drives will also thank you for putting less strain on them. If you have enough RAM, you can even create more RAM disks, just choose Disk > Add to create a temporary RAM disk (**Image G**) that wipes itself whenever the computer shuts down or restarts—perfect for sensitive tasks.







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Benchmark Battlefield 4

YOU'LL NEED THIS

MANTLE-COMPLIANT VIDEO CARD
Make sure your GPU supports Mantle.

BATTLEFIELD 4

DICE HAS updated Battlefield 4 to support Mantle, the API that's seen (by some) as the great hope for the future of PC gaming. But will it produce a massive boost to your frame rates and enable you to play with higher settings than you can under DirectX 11? Find out for yourself by benchmarking your rig under DX11 and then Mantle.

Sadly, Mantle doesn't work with any old benchmarking tools, as those tools are predominantly DirectX-based. The good news is that Battlefield 4 boasts its own integrated benchmark that works just fine with the new API, so you will be able to benchmark in a comparative fashion.

In this article, we'll show you how to benchmark your system in a repeatable way, and how to analyze the output of the benchmark. We'll then demonstrate how to convert the data to fps and draw pretty graphs. With this data in hand, you'll be set to tweak Battlefield 4 and your PC for improved performance. – **ALAN DEXTER**

1 GENERATE SOME DATA You're benchmarking to see what difference Mantle can potentially make to your system (if you're running an AMD graphics card) and/or to make sure that you're hitting the optimal balance between image quality and frame rates. We'd recommend joining a full, 64-player Siege of Shanghai server as a spectator. Use the filter system in Battlelog to find a server that checks those boxes and join it (**Image H**).

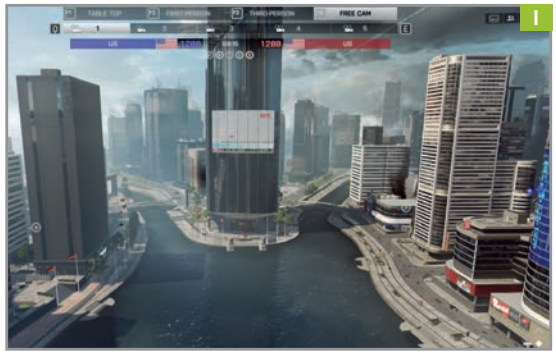
» Once you've waited an age for BF4 to connect, you should see the spectator screen. Press F4 to select free-camera mode, but don't move yet—this is a good start position for testing (**Image I**). Hit the "~" key, which is positioned to the left of the number 1 on your keyboard, to bring up the console screen. To show the current frame rate in the top right-hand corner of the screen, type the command **perfoverlay.drawfps 1** and press [Enter].

» This counter is handy if you just want to know whether your graphics settings are in the right ballpark, but you need another command to get some useful figures. In the same console window, type **perfoverlay.framefilelogenable 1** (**Image J**) and then hit "~" to close the window. BF4 is now logging your frame times. Fly around Shanghai, swooping low to the ground. You can pick your own route—just make sure to remember the route so you can repeat it multiple times. If you fly through a cloud of smoke on your sweep, for instance, make sure to fly through it on each follow-up sweep.

» Once you've done a lap and are looking back at the tower from the start (it should have taken you roughly a minute), pop back to the console again and press the up arrow to enter your last command again.

» This time, change the 1 to a 0 (so it becomes **perfoverlay.framefilelogenable 0**) to stop writing to the file. You can now quit BF4, or change your settings if you're comfortable flying blind.

H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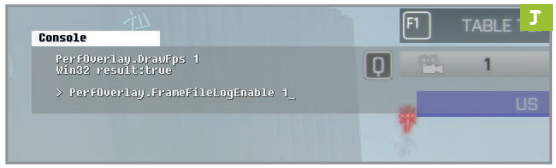

J

2 CRUNCH THE NUMBERS The log of frame times is in your Documents folder, inside a Battlefield 4 subfolder. Open Google Drive, hit the button to upload a file, and select one of the CSV files in that folder. Once the file has been uploaded, right-click it and select 'Open in Google Sheets' from the drop-down list. Once it's imported, you'll be presented with three columns of information (**Image K**). We are interested in Frame Time.

» These figures are a record of how long it takes to render a frame, but we're more familiar with frames per second as a performance measure. To convert these numbers to fps, set up a formula in column D that says **=(1000/A2)**. Copy this formula by highlighting it and hitting Ctrl +C, then click the top of column D and use Ctrl + P to paste your formula for the entire column (**Image L**).

» Select the whole column you've created and scroll down to the bottom of the sheet. Click the pop-up box in the bottom right-hand corner of the screen and you'll find that some figures have been calculated for you by default. Average frame rates, as well as minimum and maximum frame rates, are useful. Scribble these numbers down for reference and comparison with Mantle figures.

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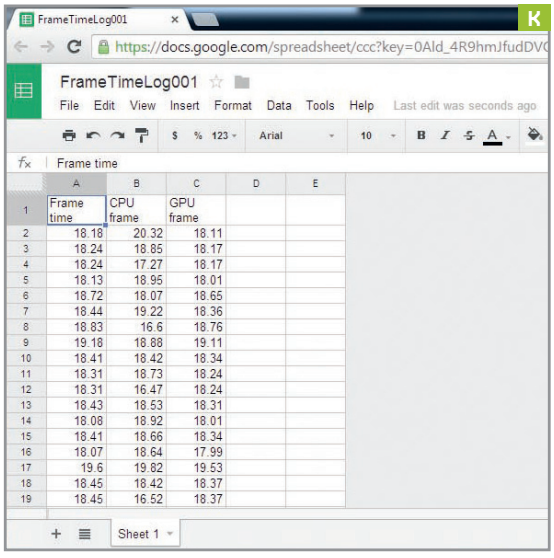

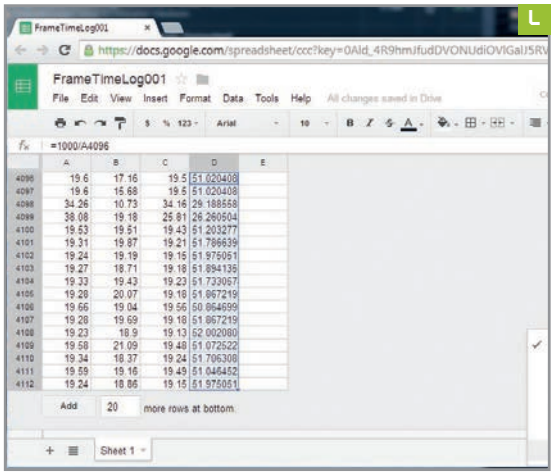

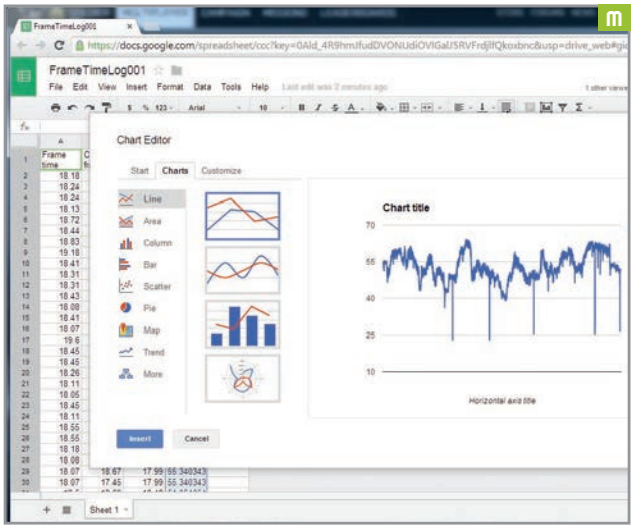

3 VISUALIZE Due to the sheer scale of your spreadsheets, the results can be unwieldy—even for just a minute's play. Therefore, producing a graph of the peaks and troughs of performance can be useful. Thankfully, it's easy to transform these numbers into something easier to understand. Simply select the column of interest and click the "Insert chart" icon, making sure you pick the line graph style (**Image M**).

» Now, tweak performance settings to ensure that average and minimum frame rates are at an acceptable level; ideally, you want your average to be well over 60 fps. We'd suggest minimums of 40 fps, although you want them as close to your average as possible. BF4 comes with a number of preset profiles that are good starting points for your tweaking; find them in the Video Settings section (**Image N**).

» If you want to try Mantle, you will need to grab the latest drivers from AMD. Make sure Battlefield 4 is up to date, then head to the same Video Settings screen and change the video rendering device from DirectX 11 to Mantle. Save the changes and then restart BF4. You can now benchmark again and see if it's worth sticking with Mantle, or if you're better off going back to DirectX 11.

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BUILD IT

JOSH NOREM **SENIOR EDITOR**

Budget Kaveri Build with Hybrid CrossFire

AMD's "Dual Graphics" aka Hybrid CrossFire lets you pair an APU with a GPU for improved performance, so we took it for a spin with a Kaveri APU and a budget GPU

LENGTH OF TIME: **2–4 HOURS** | LEVEL OF DIFFICULTY: **MEDIUM**

THE MISSION We've already written quite a bit about AMD's third-generation APU family, known as Kaveri. It's a CPU with an integrated GPU, just like with Intel's Core i7 parts that contain HD Graphics. The difference is that in the past, AMD paired a relatively weak GPU with the CPU, for predictably lame results. This time around, however, AMD has stepped it up a notch, and put the GPU on equal footing with the CPU, sticking an R7-series GPU inside the package, which is a bit more powerful than anything Intel has to on tap these days (on the GPU side, that is). Also, since AMD makes both CPUs and GPUs, it can one-up Intel by letting both pieces of silicon work together in a partnership dubbed Dual Graphics, which used to be known as Hybrid CrossFire. It's a dual-GPU setup combining integrated and discrete graphics, and it could be a good way to give your integrated graphics a healthy boost, or it could be a total waste of money. This month, we decided to build a budget-oriented gaming machine to find out for ourselves what Dual Graphics is all about, and to see whether it's actually useful, or just marketing BS.

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PREPARING TO DUAL

ALL YOU NEED to build a machine that uses AMD Dual Graphics is the right APU and GPU, and naturally, AMD has a list of compatible and recommend pairings on its website. The selection is actually quite limited, and when we asked AMD what criteria it uses to deem a particular APU and GPU "compatible," the response was, "We test the different configurations and the best user experiences based on smoothness and performance are listed as the recommended pairing." The company noted, "similarity in outright performance but also configuration" as the main criteria, and listed the A10-7850 and R7 250 as a perfect example, since both have 8 GCN units, the same memory bus width, and similar clock speeds. Due to this recommendation, we decided to use it for this particular build. With the A10-7850 selected, we decided to plop it into a Gigabyte G1.Sniper A88X motherboard, since it's a top-shelf gaming board, supports Dual Graphics, and has dual PCIe x16 slots in case we want to add a baller GPU or two some day in the future. This is a budget machine with modest power requirements, and our discrete GPU doesn't require a six-pin power connector, so we opted for a 430W Smart PSU from Thermaltake, which is the wattage we consider the minimum for a gaming box. Storage duties are handled by an Intel 335 Series SSD, which is SandForce-based. It's not the fastest SSD on the bench, but it's reliable and affordable. Since it's a budget box, we stuffed it all into Antec's newest entry-level military-themed chassis, the GX700. It's similar to the Corsair C70, but half the price.

INGREDIENTS

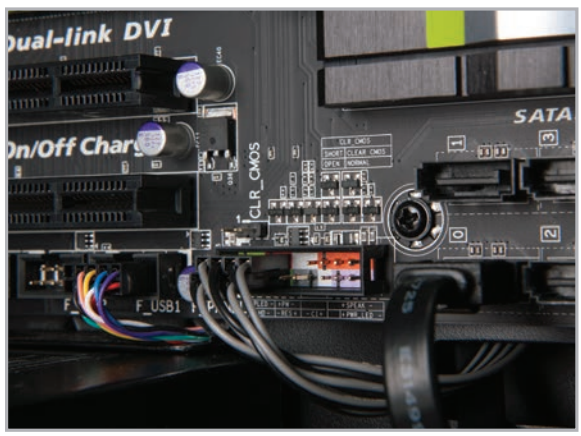
	PART	PRICE
Case	Antec GX700	$60
PSU	Thermaltake Smart 430w	$45
Mobo	Gigabyte G1.Sniper A88X	$120
CPU	AMD A10-7850K	$175
Cooler	Stock	$0
GPU	MSI Radeon R7 250	$90
RAM	2x 4GB Corsair Vengeance	$95
SSD	Intel 335 Series240GB	$160
OS	Windows 8.1 64-bit OEM	$100
Total		$845

1 CASE WORKING

BUILDING IN THE GX700 was refreshingly painless, thanks to a roomy interior, large grommets for cable routing, and plenty of room to work. Since we weren't planning on overclocking our A10-7850 APU, we went with the simplest cooling option available to us—a stock AMD cooler. These coolers don't look so hot, but they do a great job of keeping the CPU cool, and they operate quietly. Its small size also makes connecting things around the CPU socket a walk in the park. We did splurge a bit on the RAM, though, going with 8GB of Corsair Vengeance with extra-tall heatsinks. These guys are a tiny bit more expensive than the LP sticks with the low-profile heatsinks on them, but either one would work.

2 HIDING WIRES

ONE OF THE building "tricks" we like to use, if you can call if that, is to stick all the power cables that come from the front of the case to the back of the chassis, and then let them poke out right where they are connected. This keeps the interior uncluttered, and theoretically improves airflow around the power supply, since the cables aren't arranged in a rat's nest at the bottom of the chassis. We like the space between the SATA ports on this motherboard, too, and the fact that they are on the bottom of the motherboard instead of along the edge like they usually are. Anyone who has installed a slightly long GPU knows what a PITA it can be to access those ports with a GPU covering that area of the motherboard. We also like the fact that there are eight SATA 6Gb/s ports on this motherboard instead of six you get with a Z87 motherboard.



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3 GIVE ME THE CODE

PROBABLY THE most glaring nod to this case's military theme is the yellow-and-black striped cover that sits on top of the case. Lifting this cover exposes a red switch, which is actually a fan controller that can handle up to four fans. Three fans are already in the case, with two 140mm units up top where a radiator could reside one day, and one 120mm rear fan exhausting heat. You can also install up to two 120mm front intake fans, and one 120mm fan on the side door to help cool the GPU. Next to the fan controller are four USB ports—two USB 2.0 and two USB 3.0—and headphone and mic jacks.

4 THE BAD NEWS

MAYBE WE'RE SPOILED, but we're used to just pressing down on a front filter like this one and having it pop away from the case for easy removal. On this chassis, though, the metal grill that covers the front air filter is attached via four thumbscrews. You can loosen the screws with your thumbs just like their name implies, but we found we had to use a screwdriver to get them all the way out. Once removed, the air filter is held into place by clips, reminding us of this case's rock-bottom price tag of just $60. There are no free lunches, so saving money on a PC build means you lose a few amenities, such as tool-less filter covers. To install a 120mm fan, you'll need to remove the entire front cover, which can be lifted away with a bit of effort.

5 MORE BAD NEWS

HERE'S ANOTHER odd design choice from Antec: these weird metal clips that hold the covers on the 5.25-inch bays. When you pull the clips out of the way, the cover loosens and falls right out of the slot. Both the clips and the way the covers tumble out when free felt extremely cheap. Plus, the top drive bay is blocked internally by all the cabling that dangles down from the top-mounted USB and fan controller cables, so you can't put an optical drive in that particular slot, but you could put in a card reader or something similar. The mechanism that holds the drives in place is tool-less, however, so you just need to slide it to lock the drive into place. It's not the most sturdy design, but it worked well enough for our needs. Just below the 5.25-inch drive bays there is a vertical cage made of metal that holds five drives in either 3.5- or 2.5-inch form factor. You need to install drives from the right side of the case, however, as the mechanism that releases the individual drive bays resides behind the cage.

6 COOL UNDER PRESSURE

WE'LL BE honest: When we first configured this build, we slotted a 650W PSU into the bottom of the chassis because, well, this is *Maximum PC* and that's how we roll. Upon reflection, however, we realized that was a bit of overkill, especially since we had one SSD, no optical drive, and didn't need any power for our discrete GPU. Since we always tell people not to buy more PSU than they need, we decided to take our own advice and just go with a 430W unit from Thermaltake. We've used its PSUs in our GPU testing machine for the past two years with no issues, so it's a brand we generally trust. The area below the PSU is well-ventilated, and includes a filter that is easily removable, too. It sticks out a tiny bit behind the chassis, so you just have to pull it out as if you were sliding a card out of a deck, give it a good wash, and slide it back into place. You can also see that we could have fit a slightly larger PSU into this area.

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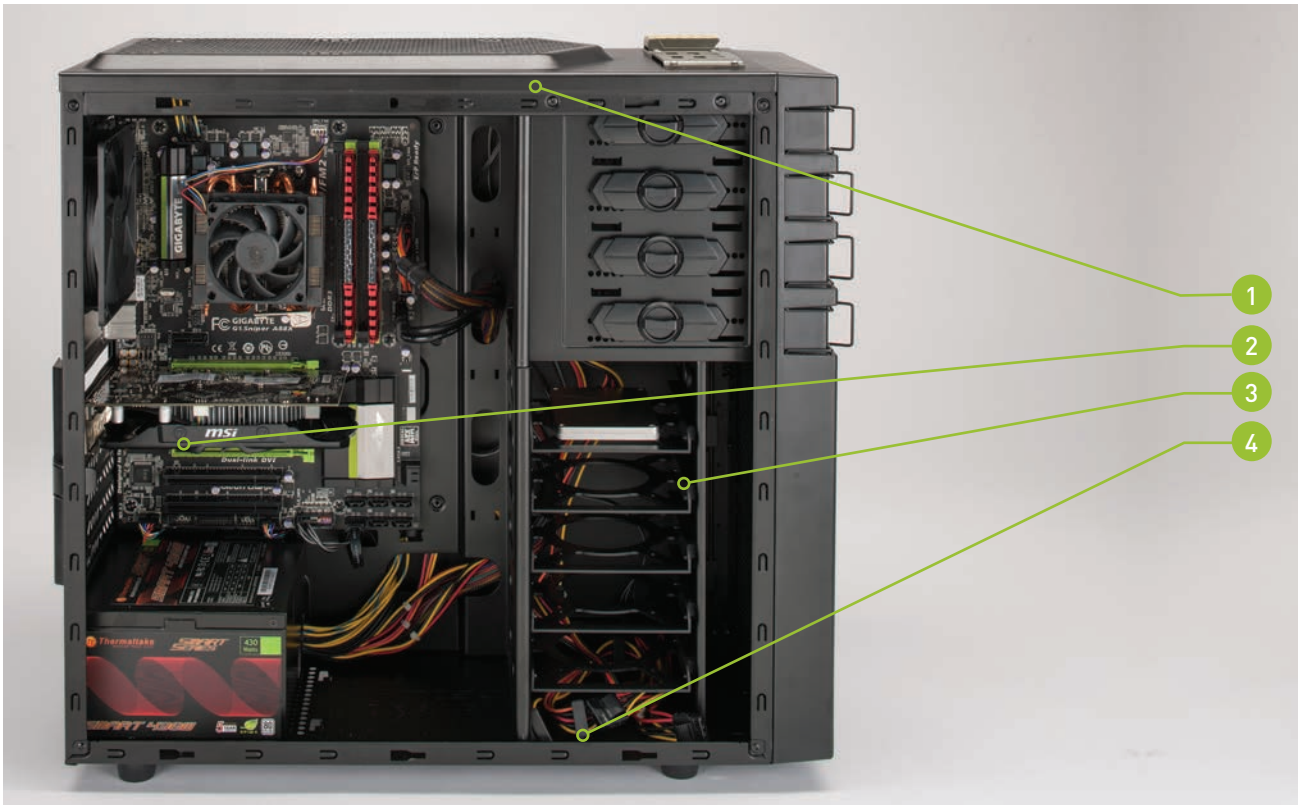

1. The GX700 case includes two 140mm fans up top, and there's room for a 240mm radiator, as well.

2. Unlike with regular CrossFire, no cable is needed to connect the GPUs for Dual Graphics; it's all done through software.

3. The hard-drive cage holds five drives and is not removable, but features plastic caddies that hold either 3.5-inch or 2.5-inch drives.

4. There wasn't enough space between the back of the case and the motherboard tray to stash our extra PSU cables, so we shoved them down here.

A GOLDEN TRIANGLE

THE PURPOSE of this build was to find out how the addition of a second GPU to a Kaveri APU machine worked, and to see whether or not it was worth the money. Once our rig was built, we added the $90 R7 250 GPU, and then tested both the GPU by itself, and then paired with the APU. Once the system was humming along, enabling Dual Graphics was as simple as ticking a box in the Catalyst Control Center, much like you would do if you were enabling regular CrossFire with two discrete GPUs.

To put it through its paces, we ran our tests suite at 1080p with all settings maxed out, but no AA because that's just a bridge too far for these cards. With Dual Graphics enabled, we were surprised to see performance go up as much as it did, which was around 40 to 50 percent in most titles that were able to use both GPUs. That is damned impressive, and more than we expected. The problem, of course, is that the overall numbers were still really low despite two GPUs working together. When we tested the R7 250 in the May 2013 issue, we noted that it couldn't quite do 1080p with all settings maxed, but we hoped the addition of the second GPU would allow us to overcome that challenge. Unfortunately, it's not enough, so any of these low-end cards are not ready for 1080p gaming—they're better suited to 720p or 1050p.

The bigger question here is if you were running a Kaveri box and decided you wanted to add more GPU muscle, what are you going to do? We can say definitively that if you want to really increase performance, you should just buy a discrete GPU like the R7 265 and forget about integrated graphics, or sub-$100 GPUs because they generally suck, at least if you are like us and used to gaming with all details enabled. It's possible that over time, AMD will work to improve the scaling between the two GPUs in Dual Graphics, so instead of seeing gains around 40 percent, we'll see it more around 75 percent, like it is with two discrete cards.

With all that said, we were impressed by both how easy it was to set up Dual Graphics, and that we saw a very noticeable gain in almost all of our test games. We don't think the combination of two weak GPUs is enough to provide a decent gaming experience, though, so in the final analysis, we'd rather just use a more powerful discrete GPU.

BENCHMARKS

	ZERO-POINT	
3DMark	711	1,043
Batman: AO (fps)	20	28
Heaven 4.0 (fps)	10.6	10.8
Unigine Valley (fps)	13	14
Tomb Raider (fps)	11.5	16.2
Hitman: Absolution (fps)	16	24

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

The zero-point machine compared here consists of a 3.2GHz Core i7-3930K and 16GB of Corsair DDR3/1600 on an Asus P9X79 Deluxe motherboard. It has a GeForce GTX 690, a Corsair Neutron GTX SSD, and 64-bit Windows 7 Professional.

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AMD R9 290X
Flagship GPU brings the pain and a bunch of new features for gamers. PG. 40
COOLER MASTER V8 GTS
This air cooler is pimpin', but how does it perform? PG. 80
UNUSUAL CASES
Three enclosures that will turn your PC into a conversation piece! PG. 52
MAXIMUM PC
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FASCINATING WEBSITES YOU DON'T KNOW ABOUT!
NFORMATIVE. FUN. UTRAGEOUS. ENTERTAINING. OT TO BE MISSED!
G. 26
HOW TO:
Encrypt your data and keep it safe from prying eyes! PG. 66
MAXIMUM PC
MICRO-TOWERS
More performance than desktops twice their size! PG. 26
CLOUD STORAGE COMPARISON
15 online services vie to store your data—for free! PG. 40
Future

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TESTED. REVIEWED. VERDICTIZED.

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88 Titanfall

90 South Park: The Stick of Truth

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Digital Storm Bolt II

Rev 2.0 ups the ante in micro-tower design

SEQUELS AREN'T easy to make. Ask the producers of *Ghostbusters II* or *The Matrix Reloaded* who probably wish they could go back in time and remove their names from the credits. It's with this fear that we approached uncrating Digital Storm's second-gen Bolt II.

While the original Bolt wasn't the first micro-tower (that credit firmly goes to Alienware, and if you're a stickler, perhaps Voodoo PC), this is the first of the micro-towers to get a sequel. Sure, others may claim generational upgrades qualify, but moving from Ivy Bridge to Haswell or installing a new GPU isn't really a sequel.

You can't say that about the Bolt II. Digital Storm seems to have looked hard at correcting the weaknesses of the original. The original Bolt was one of the thinner micro-towers, but that narrow chassis also limited its cooling ability. While Falcon Northwest could amazingly shim a custom cooler into its Tiki, which was only slightly bigger, it couldn't be done with the Bolt. That led to unpleasant acoustics when the overclocked CPU was put to work. While we dug the angular lines of original Bolt's chassis, the cover was a three-piece clamshell affair, similar to what you saw in an early 1990s case designs. It usually took us no less than four tries to put it back together after opening it.

You'll have no problems opening or closing the Bolt II. Both sides easily slip off using screws integrated into the side panels. There are also four removable metal feet integrated into the chassis that allow it to lie comfortably in a horizontal position. The redesigned case is also thicker and taller than its predecessor. The extra girth allows Digital Storm to fit a 240mm radiator inside the unit, making it the first micro-tower we've seen with a radiator of this size. We'll note that iBuypower's Revolt and Falcon's Tiki were also liquid cooled but used smaller coolers. The Bolt II gives you easy access to the CPU and RAM. It's more work to get to the GPU and drives but it can be done. We should also mention the chassis is fully custom and built stateside to Digital Storm's specs.

Inside the Bolt II, DStorm has installed a Core i7-4770K overclocked to 4.5GHz, 16GB of Corsair Dominator Platinum DDR3/1600, a 256GB Samsung 840 Pro, 2TB WD Black, and the pièce de résistance: A GeForce GTX Titan Black with 6GB of RAM.

The Bolt II's performance was fairly impressive. Our zero-point system is a six-core Sandy Bridge-E box OC'ed to 3.8GHz with a GeForce GTX 690. The Bolt II easily outran it in the benchmarks that didn't push all of the cores, and surprisingly, didn't fall that far behind in the heavily multi-threaded tasks, either. In gaming the Titan Black/Haswell kicks GTX 690's butt in Batman, and amazingly, ties it in 3DMark11.

The real gauge of performance is the Falcon Northwest Tiki, though. That PC was the performance winner of our micro-tower roundup in the November 2013 ish. FNW took the Core i7-4770K to an unheard of 4.7GHz. That 200MHz advantage amounted to about a three percentage bump in the CPU tests over the Bolt II, so FNW still holds the record for micro-tower performance. However, the Titan Black in the Bolt II gets payback over the Tiki's plain Titan, with the Bolt II having about a 6 to 8 percent frame rate advantage. That makes the Bolt II mostly a tie with the Tiki except in one area—acoustics.

While the Tiki wasn't offensive in noise, that heavily overclocked CPU and the smaller chassis made its cooling very noticeable under punishing workloads. The Bolt II was always unobtrusive. Not NUC silent, as there is a tiny bit of fan noise, but it was far less in-your-face than the Tiki.

Our last comment should be to note the beautiful "Copperhead" paint job. While custom paint jobs are always subjective in appreciation, there are usually tiny imperfections you can see when you put your nose up to the unit that let you know it was painted by hand. Not so with the Bolt II's coat, which is as perfect as a factory paint job. We would have liked more clear coats, but still, as far as custom paint goes, it's perfect.

In summary, this is a great sequel—more along the lines of *Godfather II* or *Aliens*.

–GORDON MAH UNG

VERDICT
9
KICK ASS!

Digital Storm Bolt II

+ RIKKI TIKKI Powerful; fast; quiet.

– NAGAINA Bigger than other micro towers; needs a bigger SSD.

$3,891; www.digitalstormonline.com

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	2,174 (-8%)
Stitch.Efx 2.0 (sec)	831	710
ProShow Producer 5.0 (sec)	1,446	1,211
x264 HD 5.0 (fps)	21.1	19.7 (-6%)
Batman: Arkham City (fps)	76	152 (100%)
3DMark 11	5,847	5,892

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our current desktop test bed consists of a hexa-core 3.2GHz Core i7-3930K 3.8GHz, 8GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We are running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Windows 7 Professional.

SPECIFICATIONS

Processor	Core i7-4770K @ 4.5GHz
Mobo	Asus Maximus VI Impact (Z87 chipset)
RAM	16GB Corsair Dominator DDR3/1600
Graphics	GeForce GTX Titan Black
Storage	256GB Samsung 840 Pro, 2TB WD Black 7,200rpm
Optical	Blu-ray burner
Case / PSU	Custom / 500 watt Digital Storm Bolt II Edition Gold Plus rated

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The Bolt II's chassis is a custom design made in the United States.

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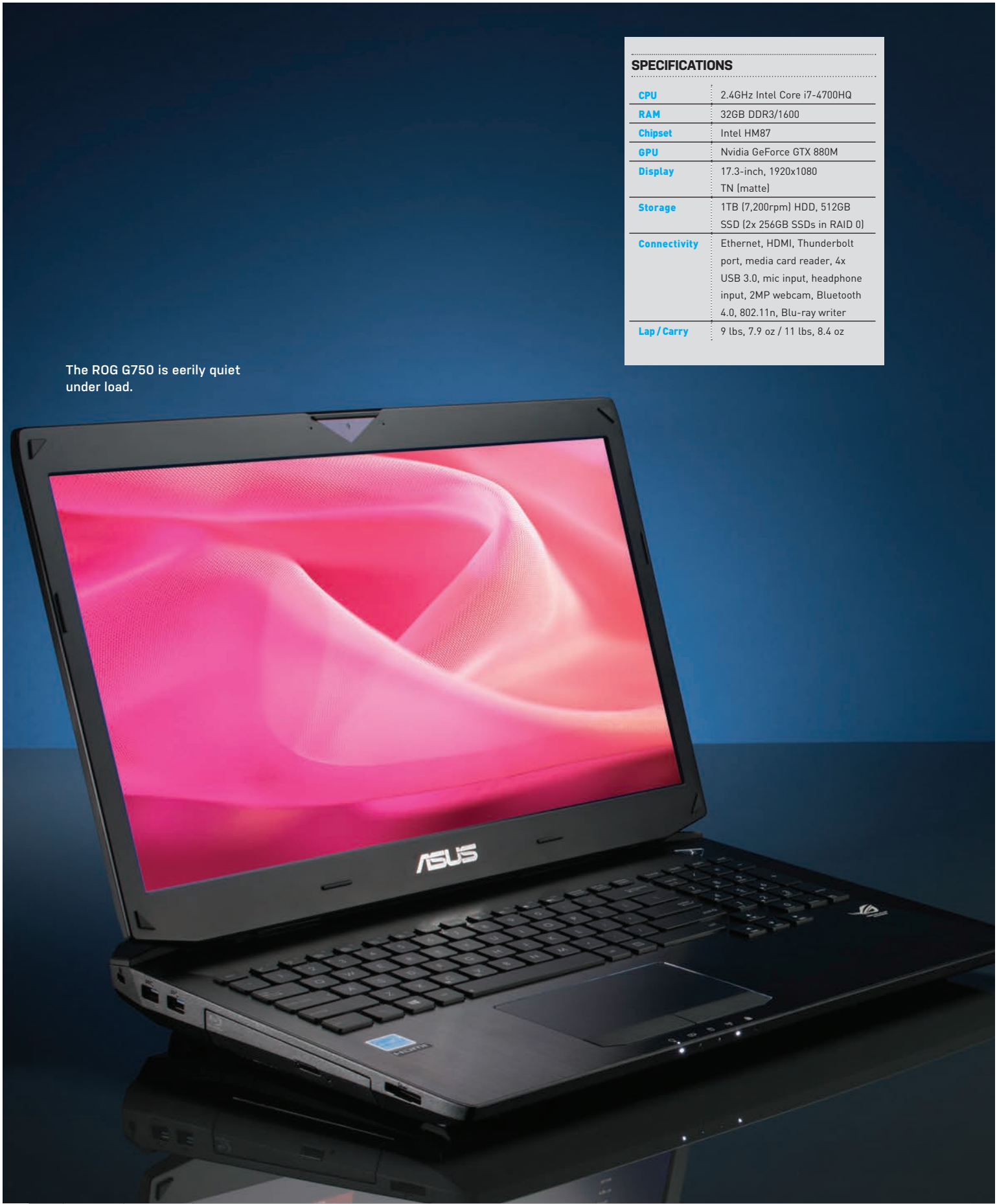

The ROG G750 is eerily quiet under load.

SPECIFICATIONS

CPU	2.4GHz Intel Core i7-4700HQ
RAM	32GB DDR3/1600
Chipset	Intel HM87
GPU	Nvidia GeForce GTX 880M
Display	17.3-inch, 1920x1080 TN (matte)
Storage	1TB (7,200rpm) HDD, 512GB SSD (2x 256GB SSDs in RAID 0)
Connectivity	Ethernet, HDMI, Thunderbolt port, media card reader, 4x USB 3.0, mic input, headphone input, 2MP webcam, Bluetooth 4.0, 802.11n, Blu-ray writer
Lap / Carry	9 lbs, 7.9 oz / 11 lbs, 8.4 oz

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Asus ROG G750

Real desktop gaming... from a notebook

LOOKING AT THE outside of the 2014 model of Asus' 17-inch ROG G750 gaming notebook, you'd be hard-pressed to find anything new. But, like mama used to say, it's what's on the inside that counts.

The real heart of the G750 is the GTX 880M, and it's a beast. It has 4GB of GDDR5, a GPU running at 954MHz, and the memory clocks in at 1,250MHz. According to our graphics benchmarks, it will run anywhere from 50 percent to 120 percent as fast as our Alienware 14 zero-point's GTX 765M. While you most likely won't be able to run the most graphically demanding games maxed-out with the card (that's what SLI and desktop GPUs are for), we were able to play Metro: Last Light on "very high" settings with frame rates around 40 FPS.

Even though the new GPU is really the star here, the other components are anything but shabby. The laptop's armed with Intel's high-end Core i7-4700HQ mobile CPU clocked at 2.4GHz, two 256GB SSDs in RAID 0, and 32 friggin' gigabytes of RAM. That much RAM is really overkill for gaming, so its inclusion is puzzling.

In our CPU tests, it performed nearly identically to our AW14, which has a very similarly clocked i7-4700MQ CPU, only slipping by 4 percent in our single/multi-threaded Stitch test. We did a quick-and-dirty storage test using CrystalDiskMark, with the G750 coming in 46 percent faster in reads and 54 percent in writes.

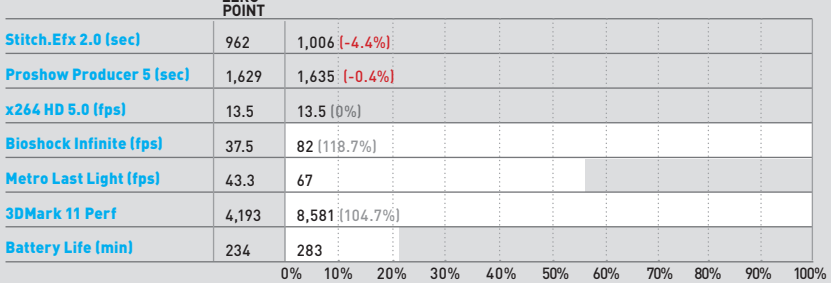
The laptop is also armed with a big 8-cell lithium-ion battery. In our video run-down test, it lasted an impressive 283 minutes, trumping our Alienware's already long-lasting offering by 20 percent. In conjunction with its big battery is "Nvidia Battery Boost," which is an exclusive feature to 800M-series GPUs. The idea behind the new GeForce Experience technology is that it puts a hard limit on frame rate to optimize for battery life. Nvidia is claiming up to 2x battery life when gaming with this feature. To test it out, we continuously looped our Metro: Last Light benchmark until the G750 keeled over. We realize that this stress test will have the GPU sweating bullets at all times, but it should at the very least represent a worst-case gaming scenario. With Battery Boost disabled, our laptop lasted 1 hour and 12 minutes. With it enabled, it lasted a whopping 4 minutes longer. That's not exactly a great showcase for Nvidia's new technology, but Asus tells us that the laptop was already designed to throttle the GPU to optimize for battery life, similarly to how Nvidia Battery Boost handles it. So for now, the jury is still out on Battery Boost.

In terms of appearances, the chassis reminded us a lot of the tumbler Batmobile from the Dark Knight movies, with its matte-black finish and sharp triangular edges. It's also quite tankish in size and weight, measuring 16.3x12.7x2.2 inches and weighing 11 pounds, 8.4oz. One happy feature of the unit is that its dual-exhaust design emits heat out of the back of the chassis, as opposed to venting through the sides and cooking your wrists as with most laptops. But more impressive is that the laptop never got loud, even under our heavy-duty benchmarks. It was frighteningly quiet. This is partly due to the large chassis and partly because the CPU and GPU each have independent dedicated cooling. Our one complaint about the chassis is that it's not very serviceable, as Asus has opted to block off the screw holes with rubber standoffs.

As great as the G570's internal specs are, the laptop unfortunately sports a TN panel. Thankfully, it's one of the best TN panels we've seen and offers respectable viewing angles. On the audio front, the notebook's 2.1 speakers are loud and crisp. The laptop's keyboard gets the job done and features subtle white LED backlighting. Its large 5-inch trackpad is also competent, has two dedicated buttons, and supports multitouch gestures like two-finger scrolling. We were disappointed that there's no option to reverse the trackpad's scrolling direction, as some of us prefer to invert the controls.

These relatively minor caveats aside, Asus has constructed a mighty fine laptop: It's incredibly powerful, has relatively good battery life, and is equipped with awesome components all around. It isn't perfect, however, as we personally think Asus went overboard with 32GB of RAM and would have rather seen that investment spent on an IPS panel. If you don't mind downgrading from two 256GB SSDs to two 128GB SSDs and opting for a DVD drive instead of a Blu-ray player, we actually recommend going with the 24GB RAM model to save $500. That configuration is especially Kick Ass.—**JIMMY THANG**

BENCHMARKS



Our zero-point notebook is an Alienware 14 with a 2.4GHz Intel Core i7-4700MQ, 16GB DDR3/1600, 256GB mSATA SSD, 750GB 5,400rpm HDD, a GeForce GTX 765M, and 64-bit Windows 7 Home Premium. BioShock Infinite tested at 1920x1080 at Ultra DX11 settings; Metro Last Light tested at 1920x1080 at DX11 medium quality settings with PhysX disabled.

VERDICT

9

KICK ASS!

Asus ROG G750

SOG Fast GPU; all-around great specs; good battery life; loud, crisp speakers.

BOG Unnecessary RAM; big and heavy; TN panel; not very serviceable.

$3,000, www.asus.com

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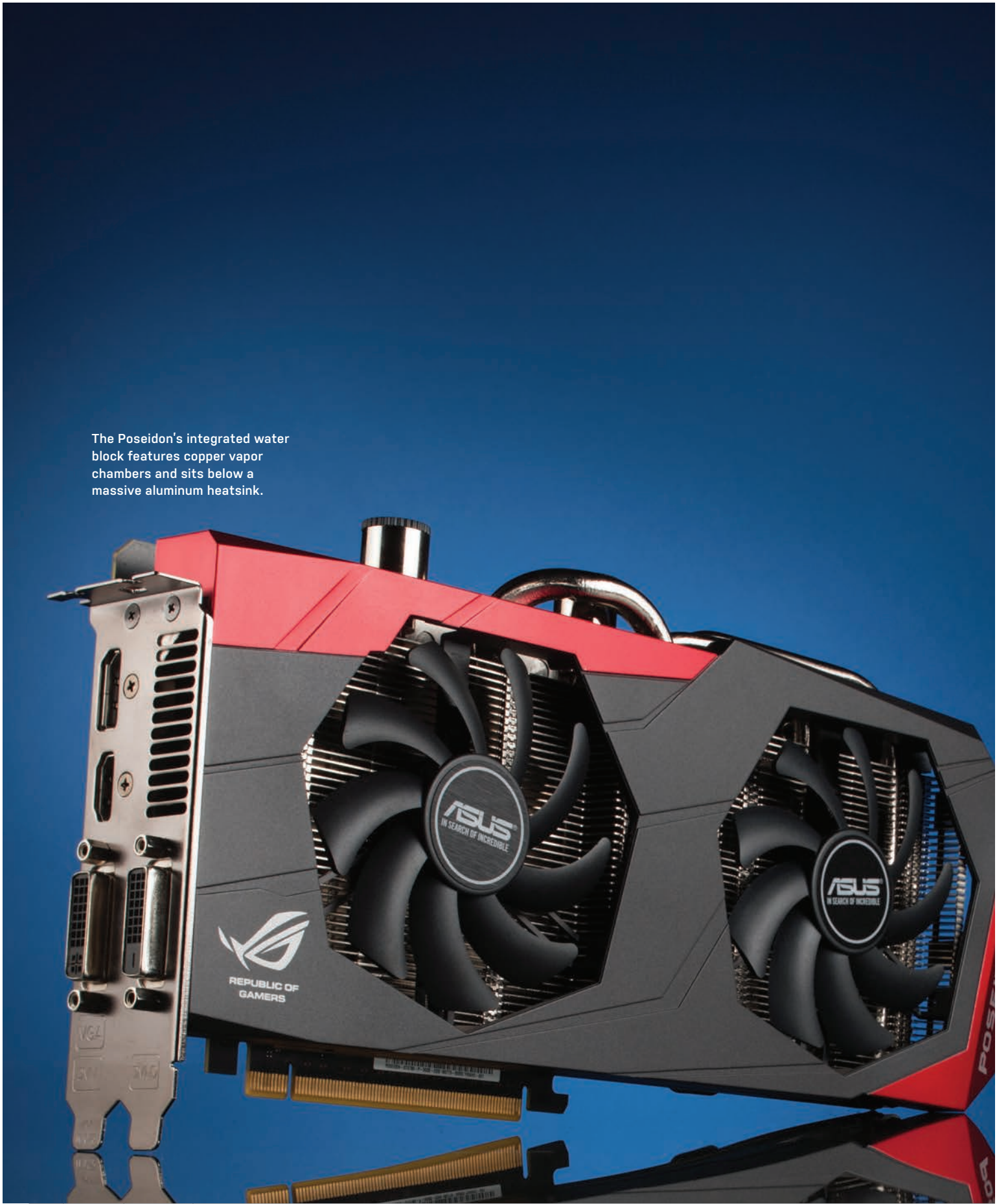

The Poseidon's integrated water block features copper vapor chambers and sits below a massive aluminum heatsink.

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Asus ROG Poseidon GTX 780

Air or liquid cooled—the choice is yours

NOBODY WOULD call the GeForce GTX 780 a particularly hot-running or noisy GPU, but that hasn't stopped Asus from giving it the Poseidon treatment via a "hybrid" air-and-liquid cooling setup. It's not a self-contained cooling system, but rather an integrated water block complete with copper vapor chambers that sits below an already-beefy DirectCU air cooler. This lets the card run just fine under its own air cooling, and lets you inject it into your liquid-cooling loop, as well. It's able to do that care of two G1/4-inch tubes attached to the integrated water block that let you attach barbs in pretty much any size ranging from 1/2-inch ID to 1/4-inch ID, so you can easily add it to your existing setup.

It's a clever and cost-saving design, because if you're rocking full-liquid, the alternative is to buy the GPU for $500, then the water block for $140 or so, then attach the block, and insert it into your loop. If you were already looking to upgrade your GPU, the Poseidon method would save you a lot of time and energy, and if you're running a pre-Kepler GPU, it would be one hell of an upgrade.

The board itself is still a two-slot card despite the added cooling hardware, and it has the same 3GB of 6GHz GDDR5 memory as other GTX 780s. It comes out of the box with a healthy overclock too, with the base clock running at 954MHz compared to the stock speed of 863MHz, and a Boost Clock of 1,006MHz compared to 900MHz. The card also has a pulsating Republic of Gamers logo in red that matches the card's aesthetic. It features an aluminum backplate for support, Digi+ VRM components, and a ROG edition of its tuning software named GPU Tweak.

For testing, we strapped the Poseidon to our GPU test bench and ran it though our tests, first on air and then on water. To test the liquid-cooled configuration, we dug out some parts we used on Dream Machine 2013, including the superb Swiftech MCP655 pump, several feet of 3/8-inch ID tubing, an XSPC 360mm radiator, and two Gentle Typhoon fans in a push-pull configuration. Sure, it's a bit overkill, but we didn't have a single 120mm radiator kit available for testing, so take the results with a grain of salt—we did use a huge radiator. In terms of performance, the Poseidon GTX 780 performed on par with the best GTX 780 cards we've tested, including the GHz edition from Gigabyte and the SC ACX model from EVGA, so it's top of its class. Temps on air topped out at a respectable 73 C, and we hit 1,084MHz. Once we strapped the liquid-cooling apparatus to it, temps never rose above 44 C, and it was so quiet we had to put our ear right next to it, and even then we didn't hear anything. It reminded us why we love liquid cooling so much, and the 29 C drop in temps over air were incredible.

Overall, this card kicks ass, but is made to satisfy a very small niche of the market. We'd never recommend it over a vanilla GTX 780, but if you are running liquid cooling and need to upgrade, it doesn't get much better than this. We do have one big complaint, though, which is that the barbs stick straight out from the card rather than being at a 90-degree angle, so when you attach the tubing, they will stick straight out from the card, too, and cause clearance problems with a case door. We ran ours with the case door removed since it was just a quick setup for testing, but long-term, we can see this being an issue unless you also use right-angle connectors. In our opinion, though, they should be built into the card. This omission is big enough that we are taking away the Kick Ass award this time; otherwise, this card is hard to fault. **–JOSH NOREM**

BENCHMARKS

	Asus ROG Poseidon GTX 780	Gigabyte GeForce GTX 780 GHz	GeForce GTX 780 (Reference)	EVGA GTX 780 ACX	AMD Radeon R9 290X (Reference)
Driver	335.23	331.82	331.58	320.49	13.11
3DMark Fire Strike	9,209	9,695	8,309	9,607	**9,737**
Unigine Heaven 4.0 (fps)	38	39	33	**40**	33
Unigine Valley 1.0 (fps)	47	47	38	**53**	36
Call of Duty: Ghosts (fps)	**54**	53	45	51	47
Crysis 3 (fps)	28	**30**	24	27	28
Tomb Raider (fps)	23	25	20	25	**27**
Metro: Last Light (fps)	**27**	25	20	24	17
Battlefield 4 (fps)	44	**47**	46	45	45
Batman: Arkham Origins (fps)	**51**	**51**	43	49	**51**
Assassin's Creed: Black Flag (fps)	29	30	30	**34**	30

Best scores are bolded. Our test bed is a 3.33GHz Core i7-3960X Extreme Edition in an Asus Rampage IV Extreme motherboard with 16GB of DDR3/1600 and a Thermaltake ToughPower 1,050W PSU. The OS is 64-bit Windows 8. All games are run at 2560x1600 with 4X AA except for the 3DMark tests.

VERDICT **9**

Asus ROG Poseidon GTX 780

+ WATER GOD Fits almost any size barb; very cool and quiet; not outrageously priced.

– WATER BOY Barbs stick straight out; no reason to run it on just air.

$600, www.asus.com

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The M6e features a full-blown PCI Express SSD in the new M.2 form factor.

Plextor M6e PCIe SSD 256GB

The first native PCI Express SSD has finally arrived!

THE PLEXTOR M6E is the first native PCI Express SSD we've been able to get our hands on, so we're excited to finally see what an SSD can do when it's not hobbled by the SATA interface and its 550MB/s bottleneck. Instead of SATA or a 2.5-inch device, this drive utilizes the M.2 form factor along with a PCI Express interface, so it can plug into any late-model motherboard and is bootable. The M.2 interface was designed for notebooks as a replacement for mSATA, as it allows for much higher capacities along with different size devices, so it can be mounted in a wider variety of locations compared to mSATA. To create the M6e, Plextor took a "gum stick" drive and mounted it to a PCI Express 2.0 x2 add-in card. Since each PCI Express 2.0 lane allows for 500MB/s of bandwidth, the two lanes connected to this card allow up to 1GB/s of bandwidth, which is around 800MB/s after deducting overhead. This isn't a massive increase over SATA 6Gb/s speeds, but it's a decent bump.

This is a change from what we've seen in the past from drives labeled "PCI Express SSD," as they were usually SATA drives bolted to a PCI Express adapter, then striped together in RAID 0 in order to overcome the SATA bottleneck. The Plextor drive is just one single slab of NAND flash, and though this PCIe drive won't be of much value to those already rocking SATA 6Gb/s drives, anyone stuck on the older SATA 3Gb/s interface should give it a look.

The drive uses a Marvell 88SS9183 controller, which as far as we can tell is somewhat new, as we've never seen it before and don't think it's been used on any consumer SSDs yet. The controller is paired with 19nm Toshiba MLC Toggle NAND, and there's also a DDR3 buffer as well but the size varies according to the drive. The drive is available in both 128GB and 512GB capacities, and includes a five-year warranty along with a 2.4 million hours MTBF, so this is certainly a top-tier product with nothing held back in terms of features or performance. At $300 for the 256GB it's more expensive than the $250 Samsung 840 Pro and Intel 730, so we were very curious to see if its performance was worth the high price tag.

Long story short: Its performance was the best we've ever seen in sequential read and write tests by a decent margin, just as expected, but it fell a bit short in Iometer and PCMark Vantage. It was eclipsed by SATA 6Gb/s drives on our Z77 test bench, so out of curiosity we ran some tests on an X79 platform and saw its PCMark Vantage score double to over 100,000, and its performance in Iometer increased by 30,000 IOPS, too. While we were pleased to see such a large performance increase, we're not sure what caused it. It set a new record in our Sony Vegas test, too, thanks to its extra bandwidth.

Overall, this drive's performance is very good, but it's not quite a big enough jump from SATA III to justify its high price tag. We love its five-year warranty, its overall speed, and it's just as easy to use as a 2.5-inch drive, but it's too expensive and lacks a robust software package like Intel and Samsung drives. Its aesthetic needs serious work, too, if it's being marketed toward gamers. All in all, a very solid drive, but not quite Kick Ass.

–JOSH NOREM

BENCHMARKS

	Plextor M6e	Intel 730 Series	Samsung 840 Pro	Sandisk Extreme II	OCZ Vector
Controller	Marvell 88SS91183	Intel 3rd Gen.	MDX	Marvell 88SS9187	Barefoot 3
Capacity	256GB	480GB	512GB	480GB	512GB
CrystalDiskMark					
Avg. Sustained Read (MB/s)	**759**	468	534	521	502
Avg. Sustained Write (MB/s)	**575**	491	514	484	499
AS SSD - Compressed Data					
Avg. Sustained Read (MB/s)	**695**	515	513	508	507
Avg. Sustained Write (MB/s)	**548**	471	495	473	494
ATTO					
64KB File Read (MB/s)	**729**	373	524	525	511
64KB File Write (MB/s, 4QD)	487	468	**497**	493	480
Iometer					
4KB Random Write 32QD (IOPS)	64,676	78,242	82,297	42,699	**83,531**
PCMark Vantage x64	52,387	49,969	75,205	38,093	**75,863**
Sony Vegas Pro 9 Write (sec)	**263**	442	294	275	314

Best scores are bolded. All tests conducted on our hard-drive test bench, which consists of a Gigabyte Z77X-UP4 motherboard, 3.2GHz Core i5-3470 CPU, 8GB of RAM, Intel 520 Series SSD, and a Cooler Master 450W power supply.

VERDICT **9**

Plextor M6e PCIe SSD 256GB

PCIE Faster than SATA; 5-year warranty; close-to-SATA price.

PATA Not much faster than SATA; no software; expensive.

$300, http://plextor.com

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SPECIFICATIONS

CPU	1.4GHz Celeron 2955U
RAM	2GB DDR3/1600 in single-channel mode
Graphics	Intel integrated HD Graphics
Storage	16GB M.2 SSD
Connectivity	Gigabit Ethernet, 802.11b, Bluetooth 4.0
Ports	4x USB 3.0, HDMI 1.4a, DisplayPort 1.2, mic-in/ speaker-out, Kensington Lock Port
Dimensions H x W x D	4.9 x 4.9 x 1.67 inches

The Chromebox sports a Haswell Celeron, but it's peppy enough for Chrome OS duties.

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Asus Chromebox M004U

Think of it as a Chromebook without the keyboard and display

WHEN WILL Chrome OS computers become so mainstream that everyone will understand what they are? A good indicator will be when we can stop explaining what the hell they are in our reviews. Today, though, is not that day, so just know that the Asus Chromebox is Chrome OS's move onto the desktop and into the living room. This NUC-style mini PC gives you all the functionality of a Chromebook, except you need to provide the monitor and keyboard. Once again, Chrome OS is a lightweight Linux-based OS that is about 95 percent comprised of the Chrome browser. For the most part, "apps" aren't installed locally the way they are with Adobe Photoshop or Microsoft Office. Instead, almost everything is run through a browser and served from a "cloud" service, using your Internet connection.

Chromebooks have run rampant through the education sector because they're affordable and low maintenance. It is essentially this decade's "thin client," with a twist: The vast majority of work and storage done on them is in the cloud. OK, with the public service announcement out of the way, the Asus Chromebox is a pretty slick box for those looking to get the Chrome OS experience on a large monitor and a real keyboard. Sure, you could plug a monitor and keyboard into a Chromebook, but it's an inelegant solution. The Chromebox can be plugged into a monitor via its DisplayPort or HDMI, and then tucked behind it using its VESA mount or simply left on the desktop. For the record, this model uses a Haswell Celeron 2955U that Asus says doesn't support 4K monitors. For 4K Chrome use, you'll need an upcoming Core i5 version of the Chromebox. The Celeron model does support 30-inch 2560x1600 panels, though.

Other parts in the Chromebox include a 16GB M.2 SSD and 2GB of DDR3/1600. The memory is running in single-channel mode, which became obvious in testing when its performance slightly lagged the Acer C720 Chromebook that has an identical Haswell Celeron but is running 4GB of RAM in dual-channel mode. You can add a second stick of RAM, but you won't really need it unless you plan on having a lot of tabs open in your browser. Performance on a Chrome OS system is difficult to gauge since we can't run x86 benchmarks, but we tried to pick some natural competitors to the Asus model, including the Acer C720, which is still our pick for the best overall Chromebook. We also compared it to a "real" PC in the form of the Intel NUC D54250WYKH, which is the thicker model, aka NUC Heavy. The NUC sports a 1.3GHz Core i5-4250U that will Turbo up to 2.6GHz. Since the only benchmark tools available are through the web browser, we installed the latest version of Chrome and Windows 8.1 on the NUC Heavy and went at it. Our tests ran the gamut of browser-based apps, and it's no surprise that the NUC Heavy won everything.

But benchmarks need context. When the heaviest workload you can perform is in a browser, it's actually very difficult to find anything that will bog down a Haswell Celeron today. Sure, you can get an ARM-based Chrome OS laptop or device to run out of gas really, really quickly, but the Haswell microarchitecture has more than enough juice for light browser work. So, frankly, once you get to a reasonable performance level, you don't need that much more with Chrome OS. We should note that the Chromebox was slightly slower than the C720 in many tests, though, which may be from its previously mentioned single-channel RAM, or because it's u sing the older browser version. Since Google pushes out the updates, though, we had no control over that.

The real question then is, "What would you use this for?" There's actually plenty we can think of, such as computerphobes who need extremely low-maintenance computing and can't work with a cramped Chromebook keyboard or screens, or just someone who needs a web-only machine. We also must say that since it has Netflix, Vimeo, and Youtube support, it would make a handy HTPC streaming box, too, and would require none of the maintenance of a "real" PC.

Sure, Chrome OS devices are an acquired taste and not for everyone, but if you're invested in the Google ecosystem and looking for a light-weight device, this little box is hard to beat. **–GORDON MAH UNG**

BENCHMARKS

	Asus Chromebox	Acer C720 4GB	Intel NUC
CPU	1.4GHz Celeron 2955U	1.4GHz Celeron 2955U	1.3GHz-2.6GHz Core i5-4250U
GPU	Intel HD Graphics	Intel HD Graphics	Intel HD5000
Threads/Cores	2/2	2/2	2/2
RAM	1GB DDR3/1600 single-channel	4GB DDR3/1333 dual-channel	8GB DDR3/1600 dual-channel
Browser Version	33.0.1750.58	33.0.1750.33.152	33.0.1750.33.152
Octane V2	9,180	10,159	**18,796**
Sunspider 0.9.1	352.6	421.6	**226.1**
Sunspider 1.0.2	340.4	392.8	**211.6**
FutureMark Peacekeeper	2,862	3,043	**4,224**
BrowserMark 2.0	4,438	4,597	**5,449**
Kraken 1.1	2,807.5	2,673.5	**1,712.6**
Wirple	865	1,186	**1,178**
RoboHornet Alpha RH-A1	94.02	96.76	**123.12**
Multi-Tasking	8,195	9,639	**11,721**

VERDICT 8

Asus Chromebox M004U

+ STAINLESS STEEL Responsive; low-maintenance; works at 2560x1600 res.

– TIN RAM should be dual-channel.

$180, www.asus.com

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The TEW-818DRU is bereft of features typically found in routers at this price range.

Trendnet TEW-818DRU

A basic router with a few bright spots

THERE ARE only a handful of wireless routers on the market that advertise AC1900 speeds, Trendnet's TEW-818DRU being one of them. The advertised speed rating is actually a combination of the dual-band data rates. An AC1900 designation means the router is capable of up to 1,300Mb/s on the 5GHz 801.11ac band, and up to 600Mb/s on the 2.4GHz 801.11n band. By adding these link rates together, router makers can slap a higher number on the box, though you can't actually combine the channels for a 1,900Mb/s connection. Still, the rating is a useful way to glean which are supposed to be the fastest routers.

This is Trendnet's flagship model. It's capable of faster speeds on the 2.4GHz 802.11n band compared to the TEW-812DRU we reviewed as part of our Wireless-AC router roundup in the February issue. That's because it supports Broadcom's proprietary TurboQAM technology, which allows the 2.4GHz band to operate at up 600Mb/s instead of 450Mbps. To benefit from this capability, your wireless adapter must also support TurboQAM.

The 818DRU further ups the ante over the 812DRU by adding a USB 3.0 port. It should be noted that Trendnet upgraded the USB 2.0 port to a USB 3.0 port on version 2 models of the 812DRU, though the 818DRU is still the better bet because it has one of each. Unfortunately, you won't always benefit from the SuperSpeed upgrade. In our file-transfer tests, we saw fast speeds when copying a 3GB file to our client PC from a Lexar JumpDrive P10 flash drive attached to the 818DRU's USB 3.0 port, but then we ran into quicksand for the remainder of our transfer tests. On the plus side, it's still handy to have to dual USB ports—one for printer sharing and the other for storage devices.

Still, speed isn't exactly this router's forte, at least not in 802.11ac mode. It trailed our zero-point router and current champ, the Asus RT-AC66U, in each of the 802.11ac tests, taking a particular beating in the backyard test. This time around, both routers struggled to contend with crowded networks, but unlike Asus's model, we've yet to see an AC router from Trendnet approach best-in-class speeds.

The 818DRU picked up the slack when we turned our attention to the 2.4GHz band. Its 802.11n performance was on par with and sometimes better than the RT-AC66U, including our backyard brawl where they tied each other at 30.7Mb/s. To get those speeds, however, we had to seek out uncrowded channels and manually select the least congested one.

Other router makers would do well to take a page from Trendnet in how to lay out a web interface. Simplicity is the key with two different views to toggle—Basic and Advanced. The latter opens up additional options, but finding where you need to go is always a breeze. On the flipside, Trendnet should take notes from its competitors when it comes to features. You won't find robust parental controls, and some basic and trending networking amenities are outright missing, like DLNA support and cloud storage. You can, however, add two additional SSIDs per band, so there's that.

Unlike the 812DRU, the 818DRU doesn't have the added benefit of a budget price tag. At $180 street, there's just not enough here to recommend it over the similarly priced RT-66U or Netgear's Nighthawk.

–PAUL LILLY

BENCHMARKS 2.4GHZ 802.11N / 5GHZ 802.11AC

	Trendnet 802.11n (2.4GHz)	Asus 802.11n (2.4GHz)	Trendnet 802.11ac (5GHz)	Asus 802.11ac (5GHz)
Bedroom – 10ft	**133**	105	261.45	**274.87**
Dining Room – 15ft, 2 walls	**123**	121	242.91	**258.98**
Entryway – 20ft, 3 walls	109	**119**	245.92	**257.87**
Driveway – 35ft	**74.3**	71.9	131.76	**136.54**
Backyard – 90ft	**30.07**	**30.07**	29.48	**104.85**

BENCHMARKS FILE TRANSFERS

	Trendnet TEW-818DRU	Asus RT-AC66U
3GB Router to PC (min:sec)	**1:51**	4:34
1GB Router to PC (min:sec)	1:51	**1:36**
3GB PC to Router (min:sec)	**5:01**	5:26
1GB PC to Router (min:sec)	4:19	**2:31**

For information on how we test routers, go to http://bit.ly/MPC_Routers2014.

VERDICT 7

Trendnet TEW-818DRU

SUMMER SUNSHINE Two USB ports; multiple SSIDs per band; slick web interface.

SUMMER SUNBURNS USB 3.0 port is sometimes slow; no DLNA support; lags behind the competition.

$180 [street], www.trendnet.com

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The GoPro 3+ Black is the smallest HD Hero cam yet.

GoPro Hero 3+ Black Edition

The action-cam king is back and better than ever

OTHER CAMERA COMPANIES may deny it, but GoPro created the action-cam market. With so many competent knockoffs out there now, the onus is on GoPro to prove its action cams still rule the roost. And the California-based company hopes to prove that with its latest and greatest Hero 3+ Black Edition camera.

GoPro's fame comes from the original HD Hero cameras, which delivered stunning video quality (for the time) in a compact form and at an affordable price. The company builds on that legacy with its sharpest iteration yet, the $400 Go Pro 3+ Black Edition. Encompassing a dizzying amount of resolutions from WVGA all the way up to 4K, and frame rates from 240 to 15—the GP3+ lives up to its name.

In addition to the camera's video features are a plethora of still-image options. The camera supports multiple megapixel resolutions, burst rates for up to 30 shots per second, and several time-lapse options that include shooting a picture at intervals varying from every half second to every minute.

That isn't to say the visual experience is perfect. The 4K setting only supports recording up to 15fps, which looks choppy, and still photos look a little desaturated and compressed. Much like its predecessor, the GP3+ struggles in low-light conditions and produces a lot of noise in dark environments. The previous Go Pro 3 Black was plagued with firmware issues, but we're happy to say we had no such issues with the GP3+ out of the box.

The biggest selling point of the camera is arguably GoPro's legendary build quality. The protective case is just a smidgen smaller than the original GoPro 3's, measuring 2.7x1.5x2.2 inches. But from our experience accidentally dropping it face-first onto concrete while skateboarding, no damage to the camera was done beyond some scuffs on the enclosure (which is easily replaced if heavily damaged). The new case does lower diving depth though, from 60 meters for previous models to 40 meters. Those who need to go to 60 meters can use the new camera in the previous model's enclosure.

As with the GP3, you can avoid the two-button interface by using the cam's integrated Wi-Fi to connect peer-to-peer with your Smartphone. The free Android or iOS app gives you video preview, and it lets you easily change settings, and stop and start recording. The video preview does lag by about a second, but it gets the job done.

The GP3+ features a buff in battery, going from the GP3's 1,050mAh to 1,180mAh. We ran it down by recording 1080p at 30fps and saw about 78 minutes of record time. Your mileage may vary, depending on settings. In image quality, the GP3+ is improved over the GP3, but you'd have to pixel peep to see it.

While the Go Pro 3+ Black Edition may not be a huge improvement over the GoPro 3 Black Edition, it's a no-brainer investment for those who are on the fence about upgrading from a first- or second-gen Hero, or for those who want to dive head-first into the action-cam scene. On top of that, you can't beat GoPro's extensive mount ecosystem. Whether you're biking or jumping out of a plane, there's a mount here for you.

Even though the GoPro 3+ Black Edition is not quite a perfect camera just yet, its flaws are minor and its strengths are kick-ass. –JIMMY THANG

VERDICT 9 KICK ASS!

GoPro Hero 3+ Black Edition

+ GOPRO Beautiful video quality; tons of camera options; durable; fantastic app; vast mount ecosystem.

– GOAMATEUR Latch can be a little tough to open/close; 4K only supports 15fps; gets hot under load.

$400, www.gopro.com

SPECIFICATIONS

Dimensions (H x D x W)	2.25 x 1.5 x 2.7 inches
Weight	4.8 ounces
Video resolutions	WVGA, 720p, 720p SuperView, 960p, 1080p, 1080p SuperView, 1440p, 2.7K, 4K
Photo megapixel options	5MP, 7MP, 12MP
Time lapse options (sec)	.5, 1, 2, 5, 10, 30, 60
Battery life (min)	77.7
Storage	microSD (up to 64GB)
Ports	mini-USB, Micro HDMI
Formats	MP4 (video), JPEG (photo)

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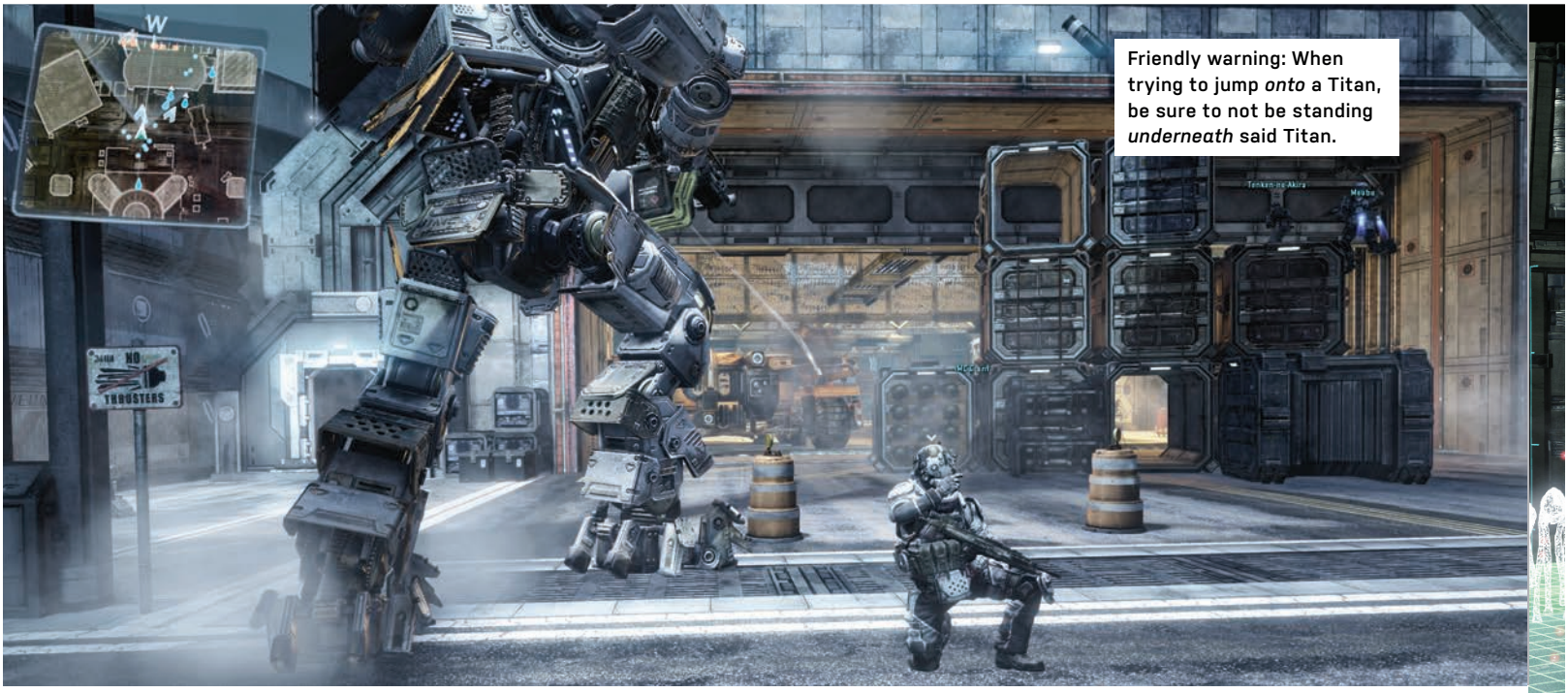

Friendly warning: When trying to jump *onto* a Titan, be sure to not be standing *underneath* said Titan.

Titanfall

A shallow but still-fun shooter

IF YOU'RE A FAN of robots; punching; and quick, in-and-out gameplay, you're going to enjoy Titanfall. You've probably already purchased Titanfall, in fact, given the dearth of titles in the not-so-subtly named "hop in a big armored thing and kick everyone's ass" genre. (Pour some out for MechWarrior, folks).

Don't listen to the early adopters, though; Titanfall is a ton of fun, for sure, but it also very much feels like a "version one" iteration of a game. It needs more. More refinement, more to do, and more options for those without 24/7 online access, et cetera. Its flaws of storyline, so-so customizability, and simplicity don't detract from what is otherwise an enjoyable first-person shooter, but we can't help but think that there was quite a great deal of hype for a title that delivers a fairly routine experience after a short while.

However, we're torn. While the game feels a bit newbie-friendly in general, we do love some of the refinements that developer Respawn Entertainment has introduced to enhance the typical deathmatch experience. Veteran online killers will clamor for Call of Duty–like complexity after a while, but they're sure to have fun getting to that point.

Not making the list of things we like is Respawn's decision to kill the game's single-player campaign and fold a half-assed story into the game's multiplayer mode. Which is to say, Titanfall's "campaign"—if one can even really call it much of one—makes absolutely no sense. In the context of a full multiplayer experience, it doesn't work. Worse, we see some pretty obvious ways in which it *could* work, but Respawn seemed to opt for the "eh, whatever" treatment instead.

We found ourselves confused by the game's overall storyline and saddened upon realizing that what you do in the multiplayer missions has no bearing whatsoever. Lose, and you get one voice over to end the mission; win, and you get the other. That's about as interactive as this title gets. Were there ever a game that cried out for a huge, branching storyline, Titanfall would be it. And it's a shame, too, given that the bits and glimmers of plot you glimpse as you begin each of the game's nine missions are fun and eye-catching—far more exciting ways to kick off a multiplayer level than a typical countdown screen (which, yes, Titanfall has, as well).

As frustrated as the game's paltry campaign mode made us feel, we found ourselves wanting to play more, and more, and more multiplayer. The MechWarrior-like, robot-fueled destruction is a hoot, and Titanfall provides plenty of (controversial) ways to run-and-gun for gamers of all types.

Where to begin? The wall-jumping, double-jumping, Spiderman-meets-Mirror's-Edge parkour gameplay makes your adventures on foot feel like a ninja with a rocket launcher. After a bit of time passes (unless you're using some fancy power-ups), you'll be able to summon down your giant Rock'em Sock'em Robot for some fun. Hop in, and you're a giant force of destruction with a fairly large target on your back; hop out, and you and your robot buddy can walk around the map together and make everyone else's lives hell. Bonus points if you actually summon your Titan on *top* of an enemy (literally).

We greatly enjoyed the game's guerilla warfare aspects: Cloaking, tracking enemy Titan pilots with our lock-on-to-kill Smart Pistol, killing AI-controlled minions from behind enemy lines, and hiding in alleyways to blast enemy titans with a rocket (or grenade). Titanfall provides a great balance between those on foot and those in armored death suits. Titans can absolutely kill you good when you run into one on foot, but craftier players can easily chip away at unsuspecting Titans with their provided anti-titan weaponry or a well-placed rodeo ride, if jumping up onto the Titan and shooting it in the weak bits sounds fun (spoiler: It is).

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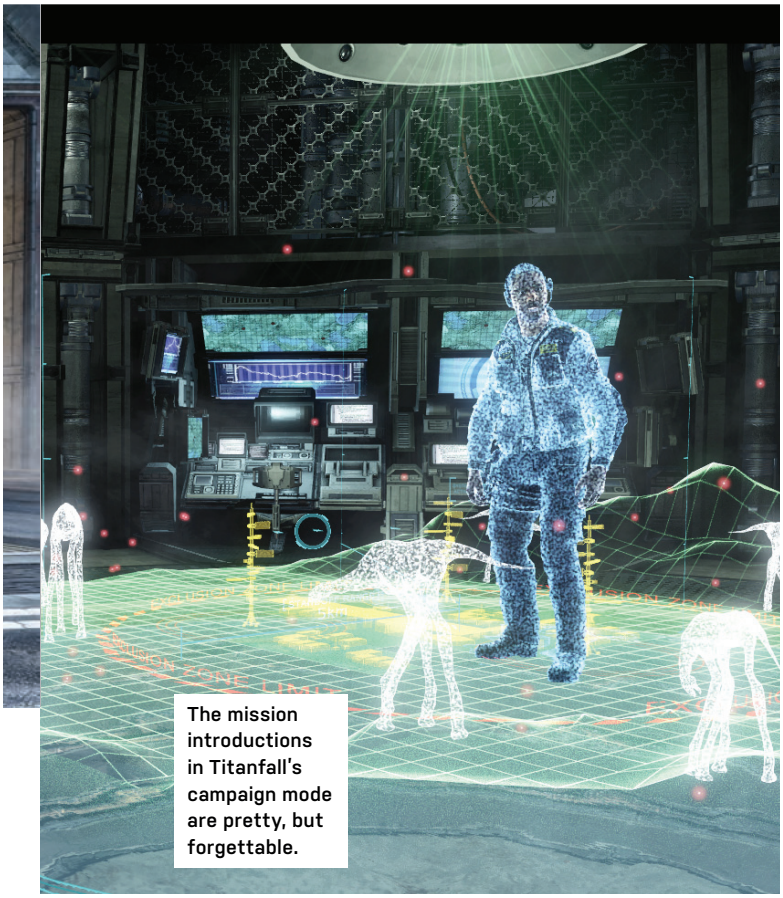

The mission introductions in Titanfall's campaign mode are pretty, but forgettable.

Smart Pistols: You do the locking-on, they do the can't-miss killing. We love it.

As mentioned, Titanfall does liven up the typical "throw rockets at people" gameplay by offering a few techniques for gamers to pick from when they jump into each level. If you're a bit more of a solo adventurer, you can run around the map and take pot-shots at the AI troops—which shaves off the amount of time you have to wait until you can summon your robot friend. If you want to push for an early lead, you can use a fancy burn card—Titanfall's one-off powerups, of which you get a maximum of three per match to use—to give yourself crazy speed, killer weaponry, an earlier Titan, et cetera. Hack enemy AI robots and they'll follow and fight alongside you; hack heavy turrets, and you won't have to be the only one putting the hurt on an enemy Titan.

A word on the enemy AI: While we like being able to obliterate hapless robots for faster Titans, the computer-controlled warriors in this game are Titanfall's equivalent of a shooting gallery. While it might be a bit much to make them autonomous death machines, killing them requires almost no effort whatsoever—it takes a bit of the novelty out of the entire premise and, worse, makes hacking them to fight on your behalf feel like a bit of a waste (especially since one well-placed Titan rocket can ruin your efforts rather effectively).

While the game's environments and visuals are lovely, we can't help but think that it would have been even better had Respawn Entertainment included more to do. Six multiplayer modes try to keep the action fresh, but we wish that the Call of Duty–like XP, skills, and customized loadout system was more diverse. Additionally, more in-game interactivity could have made Titanfall's standard shoot-outs feel much more strategic. You can hack heavy turrets and win over enemy AI on the maps themselves, but that's about it. At its core, this game is nothing but deathmatch, deathmatch, and more deathmatch.

We'd love to see some kind of *Transformers*-like setup where Titans could combine to accomplish some incredible destruction—or, perhaps, a means by which players could work together to summon that on a multiplayer map. More destructible (or changing) environments could also have greatly accentuated the formidable power these walking mechs have. The formula is simple: Battlefield 4 plus Titanfall equals take our money.

Nevertheless, Titanfall is a fast-paced shooter that you're sure to appreciate even if you're not the biggest first-person shooter fan. The matches are quick and exciting; the game offers enough strategy to give gamers of all types something fun to do; shooting down losing enemy players trying to escape each map for bonus XP is one of our more favorite things to do in a first-person-shooter; and the transition between giant, walking death robot and miniscule, pain-producing solo fighter is handled both reasonably and effectively.

Here's hoping Respawn Entertainment packs everything and the kitchen sink into Titanfall 2. We're not sure why it opted for the simpler route for its first trip to robot town—it does detract from the experience, but only to make an otherwise amazing game just plain ol' great. –DAVID MURPHY

VERDICT 8

Titanfall

+ THE DAY THE EARTH STOOD STILL Well-balanced gameplay; gorgeous visuals; plenty to do for gamers of all types.

– BICENTENNIAL MAN Can't private-match with your 11 friends; pathetic and mandatory campaign mode.

$60; www.titanfall.com; ESRB: M

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South Park: The Stick of Truth

Right-click, fart. Right-click, fart. Right-click, fart.

IT'S TIMES LIKE these when we wish we could assign a game two review scores: one for those who have obsessively watched the more than 200 episodes of the ever-foul, ever-funny animated show *South Park*, and one for those who aren't die-hard *South Park* aficionados but appreciate a good fart joke (or Kenny death) every now and then.

Fair warning: We fall into the latter camp, though it's worth tooting developer Obsidian Entertainment's horn quite a bit for the absurd level of detail that it has packed into South Park: The Stick of Truth. We're confident that every great inside joke or cameo from the series finds its way into this game in some capacity. Canada and Jesus are the two that we're safe to mention in this semi-family-friendly magazine; go rooting through Eric Cartman's Mom's room, and that's all we'll say about that. Or Mr. Slave. Or that whole "Nazi zombies" thing. The list goes on.

What doesn't translate very well in this role-playing title is just that: the role-playing aspect. You can slap your little fighter/thief/mage/Jew—yes, the latter is a class you can choose from—with all sorts of armor and weaponry of varying special abilities. We like that you can customize your gear and your character to an absurd degree through the use of "strap-ons," patches, costumes, and looks scattered throughout the game.

However, it's a bit odd that you can't customize the gear of your travelling companions—Butters, Kenny, Cartman, et cetera—of which you select one to accompany you at any given time. It's extraordinarily frustrating that the game's "Junk" category, or the dumping ground for the hundreds of inside jokes that you pick up and sell throughout the game, doesn't come with a "sell all" button. Have fun mashing.

And then there's the combat. Obsidian Entertainment's decision to add forced interaction to the game's combat–clicking buttons at certain times to activate or maximize hits and abilities is a godsend. Without it, the rock-paper-scissors battles get very numbing, very quickly; they will feel stale eventually, it just takes a bit longer.

We'll continue. The game's questing is fairly simple, your characters feel pretty overpowered both in early- and late-game (thanks, companion area-of-effect attacks), and it frustrated us that the save system depends on checkpoints—and not real-time—to work, which forced us to lose part of our progress from time to time. "Mana" doesn't automatically regenerate—perhaps a good sign, given how overpowered your magical attacks (farts) can be; some "quests," or ways to unlock character friendships in the game, don't appear in your tracker (pen and paper, anyone?); and your level of interactivity with the surrounding environment is simple, at best.

But here's the kicker: These criticisms don't matter if you're one-hundred-percent sold on the South Park universe, for Obsidian Entertainment has crafted up a game so faithful to its core, we can't see how any fan of the TV series would not want to play it through to its completion. South Park might feel simplistic in its execution, but it's as offensive as it is funny, routinely breaking the fourth wall for added hilarity and finding all sorts of absurd ways to remind gamers that the game's "epic quest" is just a bunch of kids playing around the neighborhood.

This is one of those rare instances where we disliked a game's mechanics, but were compelled to play it through to its conclusion. You might feel similarly; you might drop the game after two hours. Don't say we didn't warn you. **–DAVID MURPHY**

VERDICT **7**

South Park: The Stick of Truth

+ FEELING SUPER Offensive and funny; faithful recreation; full of inside jokes and discoverable items.

– ASKING Overly simple game mechanics; quest lacks depth; combat fails to be strategic.

$60, http://southpark.ubi.com ESRB: M

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Crucial M550 SSD 1TB

A slightly faster M500

The M550 offers several tweaks over the M500, designed to boost performance in the lower-capacity models.

CRUCIAL HAS updated it's slightly aging M500 SSD with a revamped model, and as the changes are modest, the drive's name received only a slight bump of 50 marketing buzzwords, hence the name M550 instead of M600 or similar.

Changes to the drive include a slightly tweaked Marvell controller, and use of the same 20nm two-bit-per-cell MLC NAND used in the M500. However, the lower-capacity models use NAND that has lower density per chip in order to improve performance via more parallelism. This means the 128GB and 256GB models use NAND dies with 64Gb per die, while the 512GB and 1TB models use lower-density 128Gb-per-die modules. This addresses an issue with the M500 wherein the lower-capacity drives suffered from slower write speeds than their more capacious siblings. The controller model number has also been updated from the Marvell 88SS9187 to the newer 88SS9189, with the biggest difference being better support for low-power states in order to conserve battery life in mobile deployments.

The drive is available in all sizes from 128GB up to 1TB, and in 2.5-inch, mSATA, and M.2 form factors, though we're of course testing the 2.5-inch model. There's also been a fair bit of attention devoted to data protection on the M550, just like on its predecessor. The drive has built-in parity via reserved NAND blocks, so space is set aside specifically to rebuild data in case NAND blocks suffer failure, in addition to the already-present over-provisioning to help maintain drive health. The drive also has built-in capacitors to help preserve data in-flight in case of power loss (as did the M500), and features hardware encryption support, as well. Finally, the drive sports "thermal protection," so if it gets too hot, it will throttle itself a bit until it can chill out, potentially keeping whatever laptop or tablet nice and cool, and preserving battery life, to boot. As you can see, this is a full-featured SSD, and like the previous model, it comes with a three-year warranty, but is rated to deliver the same 72TB of NAND writes over its life cycle, which works out to over 60GB of data written each day.

Since the M500 we received for testing was the 960GB version we used in the Dream Machine, it was the only drive we had to compare to the M550. Not surprisingly, the two performed almost exactly the same. They both use the same 20nm NAND with the same density, so aside from the revamped controller and firmware, the drives are identical. We suppose if you're looking to jam it into a notebook, we'd go for the M550 for its theoretical better low-power performance, but desktop users can safely flip a coin on this one. On a higher level, this drive performed extremely well for a mid-tier drive in our battery of tests. It's not the fastest SSD in this price range, as that's still the Samsung 840 EVO, but anyone who doesn't trust Samsung's use of TLC NAND in the EVO would be wise to pick up an M550. It's priced very reasonably, and as noted above, has plenty of features designed to keep your data safe. All in all, it's not our top pick for an SSD with a three year warranty, but it's a very close second. –JOSH NOREM

BENCHMARKS

	Crucial M550	Crucial M500	OCZ Vertex 460	Samsung 840 EVO	SanDisk Ultra Plus
Controller	Marvell	Marvell	Barefoot 3	MEX	Marvell
Capacity	1TB	960GB	240GB	960GB	240GB
Warranty	3 years	3 years	3 years	3 years	3 years
CrystalDiskMark					
Avg. Sustained Read (MB/s)	501	481	489	**596**	506
Avg. Sustained Write (MB/s)	482	446	488	**591**	442
AS SSD - Compressed Data					
Avg. Sustained Read (MB/s)	514	493	503	**855**	488
Avg. Sustained Write (MB/s)	478	439	491	**1,002**	429
ATTO 4QD					
64KB File Read (MB/s)	466	495	**519**	**519**	505
64KB File Write (MB/s, 4QD)	470	442	479	**659**	429
Iometer IOPS					
4KB Random Write 32QD (IOPS)	84,748	83,710	65,242	**88,859**	24,430
PCMark Vantage x64	76,251	71,619	72,435	**100,797**	32,509
Sony Vegas Pro 9 Write (sec)	315	485	323	**272**	290

Best scores are bolded. All tests conducted on our hard-drive test bench, which consists of a Gigabyte Z77X-UP4 motherboard, 3.2GHz Core i5-3470 CPU, 8GB of RAM, Intel 520 Series SSD, and a Cooler Master 450W power supply.

VERDICT 9

Crucial M550 SSD 1TB

+ CRUCIAL Quite fast; data protection features; very affordable.

– TAKE IT OR LEAVE IT Not the fastest; not much different than M500.

$530, www.crucial.com

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LAB NOTES

JOSH NOREM **SENIOR EDITOR**

So long, for reals this time

The third time has certainly been the charm

THROUGHOUT MY journalism career, *Maximum PC* has always been a bit like the mafia, in that just when I thought I was out for good, I always ended up coming back. Starting in 1999 under Brad Dosland, then again in 2005–2006, and now, from 2012 to today, I've been lucky enough to serve three tours of duty here, making *Maximum PC* my home away from home. Instead of boring you with nostalgic ruminations of times past, chips overclocked, and lab shenanigans, I'll simply conclude by saying that though I have always enjoyed my time here, I once again find myself feeling the need to move on. So, here we are. I want to give a huge thanks to Gordon and Katherine for taking me back each time, and helping me grow both personally and professionally, and for being so awesome to work with over the past decade. I also want to thank Jimmy, Tom, and Richard for putting up with me over the past year and a half, and to Future US for supporting our mission of Pure PC Power. But most of all, I want to thank you, the readers.

Whether it's the kind gentleman who brought us a hand-painted magazine logo all the way from the Philippines, the people who leave us reviews on iTunes, or the personal emails I receive about something I wrote in the magazine, the only reason we exist as an entity is because of you. Without your loyal support, we'd all just pack it up and go home. We might not say it enough, so I want to put it out there one last time: Thank you for your support of the magazine. It has meant the world to me, and it still does to all the editors on staff. Though I will miss Gordon's borderline illegal hardware hoarding (due to fire codes and general safety), I'll miss all of you the most. With Gordon at the helm of *Maximum PC* now, the magazine is in very strong hands, and I can't wait to see what he has in store. I will probably also still freelance a bit, so you're not completely rid of me yet. I guess I just can't quit you.

Josh Norem, 2000

JIMMY THANG

Online Managing Editor

Even though Facebook's acquisition of Oculus VR for $2 billion leaves a sour taste in my mouth, I can acknowledge the upside of the deal. Having tried the new DK2 headset at GDC, I can tell there are still issues, among them being that the 1080p screen isn't sharp enough and the 75Hz refresh rate isn't high enough. Prior to the acquisition, the problem was that Oculus had to rely on off-the-shelf parts, but now with Facebook's backing, the company should be able to design and build proper high-end hardware. My biggest fear is that Facebook will throw up a walled-garden ecosystem, but hopefully that won't be the case.

TOM MCNAMARA

Associate Editor

Over the year or so since I started here, I've been amazed at the sheer variety of x86 computing form factors. In the past month, I went from building a $4,200 tri-SLI Hammer of the Gods rig to holding a $249 Windows 8.1 tablet in my hand, and each is powerful in its own way. The aforementioned hammer will game capably at Ultra HD, while the tablet brings respectable Windows computing performance to a price tier that did not exist even a year ago. I think democratized computing is awesome, especially for a society that hopes to compete in the 21st century.

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First Look: AMD Radeon R9 295X2

The fastest GPU in the world (maybe)

THIS MONTH, AMD unveiled its Ace card for the R9 290 series of Hawaii-based GPUs: the dual-GPU R9 295X2. This dual-slot behemoth marries two fully loaded R9 290X GPUs onto one PCB, thanks to an integrated "hybrid" air-and-water cooler designed by Asetek. Since everything is kept nice and cool by the maintenance-free cooling system, both GPUs are able to run at full speed and under load at all times, instead of throttling like the original R9 290X reference board. That card, which was supposed to top out at 1,000MHz under load, ended up running at around 920MHz or so, but the R9 295X2 is clocked at 1,018MHz, so it's even higher than the original GPUs that it uses.

The card features two full R9 290X Hawaii cores, so specs are exactly double. It features 4GB of GDDR5 per die, a total of 5,632 Stream Processors, and 12.4 billion transistors. For comparison, a Haswell CPU from Intel has 1.4 billion transistors, so this is an absolutely massive amount. AMD says the card can do roughly 11.5 Tflops of floating point computation. The Titan Z from Nvidia, which has not yet been released, should be good for about 9 Tflops, so on paper, AMD has the advantage when it comes to computation.

AMD is rating the card at 500W TDP, which is significant since it never gave an official number for the R9 290X. This should theoretically be the same for the Titan Z, but Nvidia hasn't given that number yet, so we'll have to wait and see. Also, since the Titan Z uses the more efficient Kepler architecture, it's completely air-cooled, so its cooling is a bit less extravagant. The Titan Z is also a three-slot card, so it's much thicker than the R9 295X2. It is also twice as expensive at $3,000, compared to the R9 295X2's $1,500 price tag.

Some new features (for AMD) on this card include a glowing Radeon logo on the side that's visible through a case window. Yes, it's exactly like the green GeForce logo Nvidia has been rocking since the debut of its Kepler cards in 2012, and we must say it's about time. The centrally located fan is also lit by a red LED, so it will add some mood lighting to your chassis. Another first: The card's cooling shroud and backplate are made of metal, giving it a rock-solid feel and plenty of heft. Though it only takes up two PCIe slots, it's very long at 12 inches, so you will need a long case to deploy it.

Blah blah blah, right? We know, you want to see benchmarks. Well we got the card right before we went to press, so we haven't given it a full shakedown yet. But we can reveal a few things: For starters, the card runs very cool and extremely quiet. It hit around 65 C under load, and ran at 1,018MHz all day long while emitting a gentle hum. Installation is also simple, with its 120mm radiator. In games that support dual-GPUs, performance was record-breaking, which is no surprise. Indeed, anything less would be a disappointment. It's also the first single GPU we've seen that can run 4K resolution at the highest settings at 60fps, most notably Battlefield 4, Far Cry 3, Batman: Arkham Origins, and CoD: Ghosts. It also hit almost 16K in 3DMark, whereas a GTX 780 Ti hits just below 11,000.

The bottom line is this is one fast GPU, possibly the fastest card we've ever tested. Tune in next month for a full review, and hopefully a comparison to the Titan Z! **–JN**

Behold Project Hydra—dual R9 290X GPUs running on liquid-and-air cooling.

GEEK TESTED & APPROVED

Free to Play: The Movie

Though Valve's documentary *Free to Play: The Movie* may seem like a long advertisement for its popular online game, Dota 2, it's actually much more than that. The film, which is available for free on Youtube, is a fascinating examination of the often misunderstood world of esports. The action is centered around three players, one each from the United States, Ukraine, and Taiwan, traveling to Valve's inaugural Dota 2 tournament. The competition pitted teams of five players against each other from all around the world, and offered an unheard of at the time $1.6 million prize pool. Instead of standard nerd worship or Dota 2 fanboyism, you get to see the trials and tribulations of the protagonists, and the narrative is surprisingly gripping.

While a movie about esports may sound too niche or boring for non-competitive gamers, we aren't pros, and we loved this movie. The fact that it's free makes it impossible to not recommend.

Free, http://bit.ly/f2movie **–JT**

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LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> We Just Do It That Way
> Windows 8 Sellout
> Elite PC Builders Do Matter

Still Upside Down

In the Feb 2014 *Maximum PC*, I was puzzled by Josh Norem's reply to "My Case Is Upside Down!" Is it me or did Josh completely miss the point? The reader asked why current rigs are built "upside down," which I took as a comment on why all standard left-side opening cases have the horizontally mounted video cards with the fans pointing down toward the bottom of the case, instead of the top where it would be easier for heat to rise. Josh somewhat addresses the question by pointing out the blower-type coolers on newer video cards, but I don't think he really answered the question. I believe the real answer behind this conundrum is that it's a carry-over from the horizontal desktops of yore, where the cards were mounted vertically and the direction of the fan was insignificant since it would have the same effect on either side of the card. As we switched to towers, we began by simply putting desktops on their left side—but I think we picked the wrong side!

—Tim Olvera

SENIOR EDITOR JOSH NOREM RESPONDS: You might be correct, Tim—it's possible he was referring the orientation of the fan on the GPU, but I focused most of my answer on the reason for cases that are "upside down" in comparison to traditional ATX cases in that the GPUs are oriented vertically instead of horizontally. Though your remark about having the GPU fan on top of the card so that the hot air could rise naturally makes sense, it wouldn't work given the proximity to the CPU cooler. Plus, all the hot air from the GPU would be sucked into the GPU, as well, making for a vicious cycle of overheating for both components. Regardless, the ATX form factor could really use a redesign, given the massive spike in power consumption from both a CPU and GPU standpoint. Apple's new Mac Pro is certainly a "fresh" design, but there's no way in hell a PC user would ever put up with that level of proprietary design. Until the industry as a whole can coalesce around a design everyone likes, we're stuck with ATX for the near, and perhaps even distant, future.

I Care

In your February "Letters" section, Bob E. wrote that he didn't care to hear news about "elite" PC system builders and that most, if not all, of your readers felt the same. Well, Bob, I think you need to take your head out of the sand and see the world as it really is. I'm a DIY'er just like you are, and I have not built a computer but I have changed out every component of a computer. The most frustrating part of upgrading or building a computer is when you spend months researching for that perfect component, and then after ordering and installing it, your computer does not work. Doing all the diagnostics and then having to return the component to the retail/online dealer is not a fun part of our hobby/craft.

An "elite" PC builder, in most cases, takes that problem out of the equation. These builders have a daily working relationship with component manufacturers. If a component fails during the stress test, the manufacturer takes the defective part back and immediately replaces it. My last two computers have been from Digital Storm. Did it cost me a few hundred dollars more than what it would of cost me to build them myself? Yes. But both systems ran straight out of the box. Single-component upgrades I will still do myself, but major upgrades are a part of my past. I don't have the patience and I don't want to deal with the frustration of having one small part of my new build cause a failure of the whole system. So, *MaximumPC*, I want to hear news from/about boutique PC builders if it affects the PC industry.

—Ted Maynard

We Can't Tell if This One Is Serious

I have been a loyal reader since you were *boot* magazine. I've been building PCs for myself and others since 1990. I am not a gamer, but I love the tech. Thanks for the mag on the "Cheapskates Guide to Power Computing." I can over-clock all my hardware, but haven't. Thanks!
Sent from my iPad

—Aurelia

How Much Is Microsoft Paying You?

Kudos to readers Knipe and Patel for taking you to task for your misguided support of Windows 8 (Letters, March 2014). Knipe hits the nail on the head with his comments about Microsoft's arrogance and disconnect from the needs of its users. For some

↘ submit your questions to: comments@maximumpc.com

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time, I have been dumbfounded by your position on Windows 8, but I now came to the realization that you are likely supporting it primarily for business reasons. You likely came to the conclusion that in order to remain viable, your magazine must attract more users, and as the PC manufacturers sell more PCs with Windows 8, you will only attract those new users if you support that operating system. I realized this when I remembered that this is not the first time you have done this. When Vista came out, the public outcry was similar, but in a head-to-head comparison of Windows XP and Vista you gave Vista a small nod, betraying the sensibilities of many of your readers. Please remember that when you allow business decisions to cloud your judgment, you are walking a slippery slope. First, as you reported in April of 2014, PC manufacturers are listening to the outrage of the buying public and are beginning to roll back the clock on Windows 7, so your bet may not pay off as much as you had hoped. Second, you are losing credibility with a significant portion of your readership, who likely see through your tactics. Since the days of *Byte*, I have relied on you to tell it like it is. It is disappointing to see that I can no longer trust you to do so. I feel like I am losing an old friend.

—George Kapalka

DEPUTY EDITOR GORDON MAH UNG RESPONDS: Sorry, I'm having a problem typing on my keyboard because of the Publisher's Clearinghouse–sized checks blocking access to my iMac.

Seriously, I can tell you that if there's a speed dial from Microsoft HQ, we're not on it. We can't even get Microsoft to acknowledge that desktop enthusiasts nor *Maximum PC* even exist. Maybe if we painted ourselves like some Live Tiles and danced around on a tablet we'd get some attention.

That aside, I can also tell you that we don't care what OS the vendors sell. Alienware's laptops all ship with Windows 7, for example, and we don't mind at all. For the most part, we're pretty neutral on it. Even Josh, who previously was our biggest staff hater on Windows 8, says he has made peace with it so long as he can install Classic Shell.

But I will restate my position again: Windows 8 is not that bad. Your problem, I believe is, that you believe the failed Modern interface is Windows 8. To me, it's not. And yes, Modern is an absolute failure at this point, and it's also something I don't ever use. I use Windows 8 strictly in desktop mode, and being able to manually trim my SSDs and getting faster USB 3.0 transfers, among other truly improved under-the-hood features, makes it better in my book. I also think besides arrogance, you can also possibly ascribe desperation. I truly believed Microsoft needed to make a bold move that would change the game on tablets, but it backfired and even its loyal PC desktop users are now mad as hell.

Finally, I'd like to say that back in the Windows Vista days, you could get no one on staff who would scream and throw tantrums over Windows Vista more than me. It broke hardware audio, had horrible drivers and was just poo out of the gate. Once SP1 and SP2 shipped, though, Vista (though still a pig over XP) was workable.

[NOW ONLINE]

10 BEST UNREAL ENGINE 3 GAMES

It's been ten years since Unreal Engine 3 came out. To commemorate the game engine from Epic Games, we look back at the 10 best UE3 games. With more than 100 games that use the UE3 engine, narrowing the list down to 10 was a doozy. UE3 did, after all, jumpstart several notable franchises that include Gears of War, BioShock, the Batman Arkham series, and much more. For the complete list, head on over to http://bit.ly/Unreal3MPC.

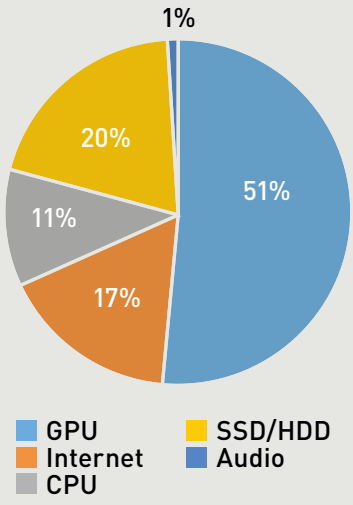
Facebook Polls

What's the single best PC upgrade that you've ever made?

We have readers who've been building for longer than the magazine's been around, so we asked those who are on Facebook to give us their input. Here are some of our faves.

Scott Penturff: I added a hammer to my MacBook, violently.
Bob Hunter: 3DFX Voodoo 1. I must be old.
John Pedroza: Going from Windows 8 back to Windows 7. :)
Kevin Harmon: Slide-out cupholder.
Dom Inic: My SSD. I love short load times. SPEED!!
Jeremy Ball: Switching to Geico... wait, what was the question again?
Steafan Edward Murray: Christmas lights; they added a good 0.5GHz to my CPU.
Bassam Masrah: EVERYTHING!
Jeff Humphreys: 4 cores to 8 cores. Because science.
Jody Morris: Commodore Data Cassette player.
Ben Nacorda: Adding a CD writer to my 386.
Sean DeFreese: ANY aftermarket CPU cooler.
Jimmy Sutton: From a GT 240 to a GTX 580.
Jason Jones: Op-amp sound card.
Christopher Quattro Lee: Putting my SSDs in RAID 0.

If you could have just one PC upgrade, what would it be?



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BASELINE

INGREDIENTS

PART			PRICE
Case	Corsair Vengeance C70		$108
PSU	Corsair TX750M 750W	NEW	$95
Mobo	Gigabyte G1.Sniper Z87	NEW	$168
CPU	Intel Core i5-4670K		$240
Cooler	Cooler Master Hyper 212 Evo		$35
GPU	EVGA GeForce GTX 760 02G-P4-2763-KR	NEW	$260
RAM	2x 4GB G.SKILL Ares Series F3-1600C9D-8GAO	NEW	$65
Optical Drive	Samsung SH-224DB/BEBE		$20
SSD	Samsung 840 EVO 250GB		$155
HDD	Seagate Barracuda 1TB		$65
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $1,311

WE CALL this build the "baseline" because it's the bare framework for an expandable system. For example, a single video card doesn't need anywhere near 750 watts of power, but those watts are reserved for a second GPU down the road. The Gigabyte G1.Sniper Z87 motherboard is also well-suited for dual video cards and can deliver respectable overclocking, and the Intel Core i5-4670K is a high-grade workhorse to pair with it. The Corsair C70 case gives you plenty of options for cooling, too, so you can always upgrade from a Cooler Master Hyper 212 Evo air cooler to a closed-loop liquid cooler later. The Nvidia GeForce GTX 760 remains the best bang-for-the-buck GPU, but this month we went from the SC version to the vanilla ACX due to pricing fluctuations.

PERFORMANCE

INGREDIENTS

PART			PRICE
Case	NZXT Phantom 530		$130
PSU	XFX P1-850B-BEFX 850W		$145
Mobo	Asus Sabertooth X79		$320
CPU	Intel Core i7-4820K		$305
Cooler	Corsair H100i	NEW	$105
GPU	EVGA GeForce GTX 780 03G-P4-3784-KR		$530
RAM	4x 4GB G.SKILL Ripjaws F3-12800CL9Q 16GBRL		$150
Optical Drive	LG WH14NS40 Blu-ray Burner	NEW	$68
SSD	Samsung 840 Evo 500GB		$280
HDD	Seagate Barracuda 3TB		$110
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $2,243

THE 280MM NZXT Kraken X60 CPU cooler's availability was sketchy at press time, so we replaced it with the Corsair H100i. Its radiator is a bit smaller at 240mm compared to the Kraken's, but it's quiet and reliable. We're sticking with the Core i7-4820K CPU since it's an LGA 2011 part, so it offers more bandwidth for multi-GPU setups than a Haswell-based LGA 1150 system. The CPU is slower in some tests than a Haswell part, though, so it's not for everyone. The GTX 780 is a great card for gaming at 2560 resolution, and two of them can handle Ultra HD quite well, should we feel the need to upgrade in the future. The NZXT Phantom 530 case has lots of room for activities, so we're sticking with it for now.

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ULTRA

BY THE TIME you read this, the high-end landscape will already be in a period of transition. Nvidia just announced the GeForce GTX Titan Z, which combines two GTX Titan Blacks onto one dual-slot card, and AMD has announced the dual-Hawaii R9 295X2 monster GPU. Upgraded Haswell CPUs will be coming to this LGA 2011 workstation tier sometime this year with DDR 4, SATA Express, and bunches of native SATA 6Gb/s ports. So what you're looking at is the calm before the storm.

This rig is still highly respectable, though (as it should be, for this kind of money). The Corsair Obsidian 900D super-tower case has easily fit every closed-loop water cooler we've ever used, and it won't break a sweat over complicated custom loops, either. The 1,250-watt XFX ProSeries will handle three GPUs easily. Speaking of which, we're holding steady with two GeForce GTX 780 Ti video cards despite the Titan Black being announced, since we just use it for gaming and don't need double precision in our GPUs.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best.

INGREDIENTS

PART		PRICE
Case	Corsair Obsidian 900D	$340
PSU	XFX ProSeries 1,250W P1-1250-BEFX	$250
Mobo	Asus X79 Deluxe	$340
CPU	Intel Core i7-4930K	$580
Cooler	Cooler Master Glacer 240L	$140
GPU	2x EVGA GeForce GTX 780 Ti 03G-P4-2884-KR	$1400
RAM	4x 4GB G.SKILL Ripjaws F3-12800CL9Q 16GBRL	$155
Optical Drive	LG WH14NS40 Blu-ray Burner	$68
SSD	Samsung 840 Evo 1TB MZ-7TE1T0BW	$460
HDD	Seagate 4TB Desktop HDD ST4000DM000	$165
OS	Windows 8.1 64-bit OEM	$100

Approximate Price: $3,998

UPGRADE OF THE MONTH
COOLER MASTER NEPTON 280L

This 280mm closed-loop liquid cooler scored a 9 in our April issue and is still highly recommended, if a bit bulky. It's sturdy and strong, like an Old West gunslinger. We'd be happy to put it in our Blueprint builds along with the smaller Glacer 240L, but they can be a bit difficult to find in stock. **$140, www.coolermaster-usa.com**

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